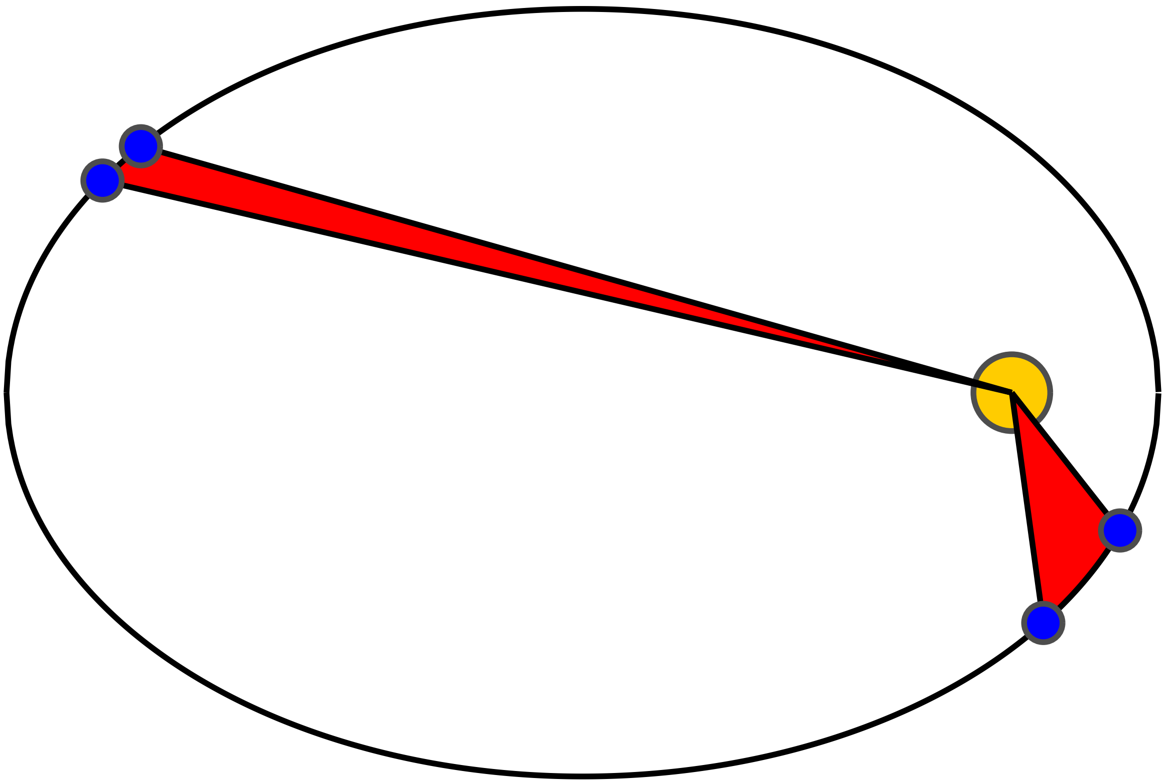
Kepler's Second Law

(Law of Equal Areas)

As the planet moves, an imaginary line joining the planet and the Sun sweeps out equal areas in equal time intervals.

(Freedman, p75)

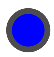
As the planet moves closer to the Sun it moves faster then when it is farther away.



Newton's First Law of Motion:

That every body continues in it's state of resting or of moving uniformly in a straight line, except insofar as it is driven by impressed forces to alter it's state.

(Densmore, p96)



planet

Newton's First Law of Motion:

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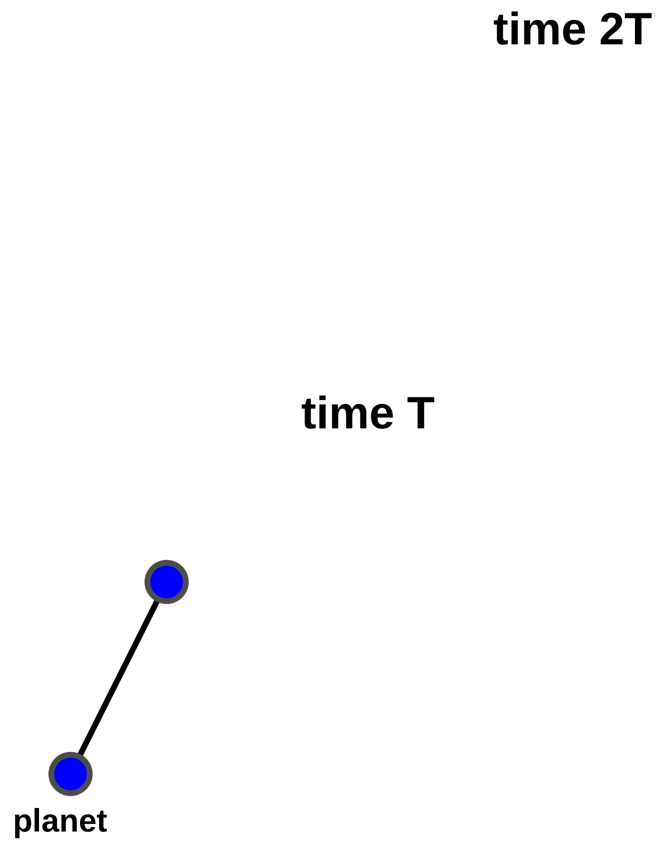
(Densmore, p96)

Each planet represents the points where the planet moved in the time T.



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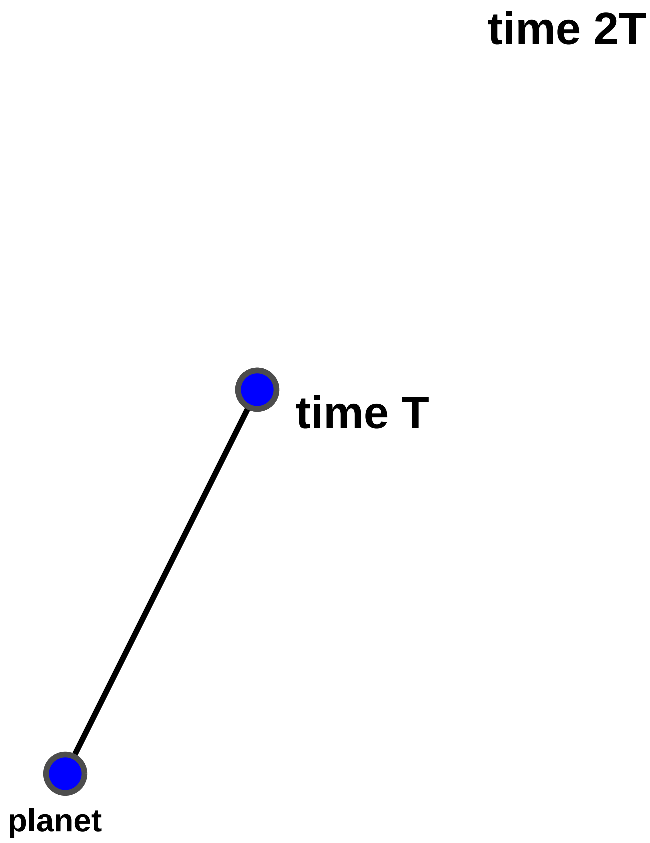

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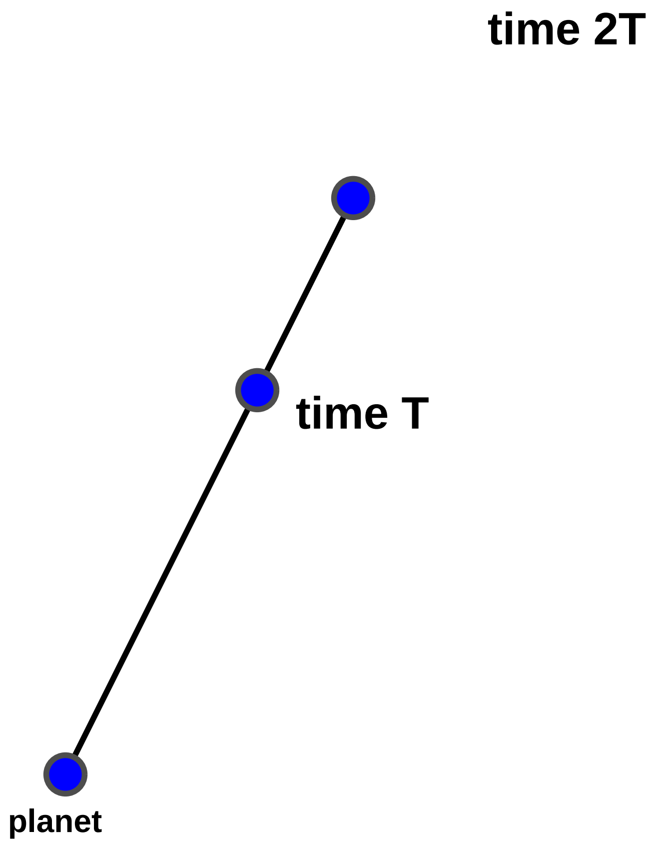

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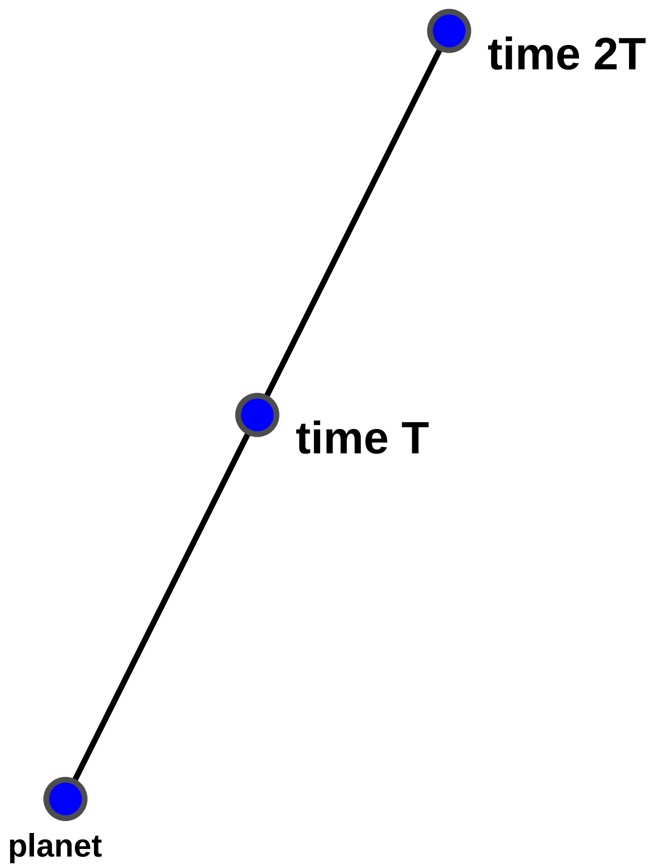
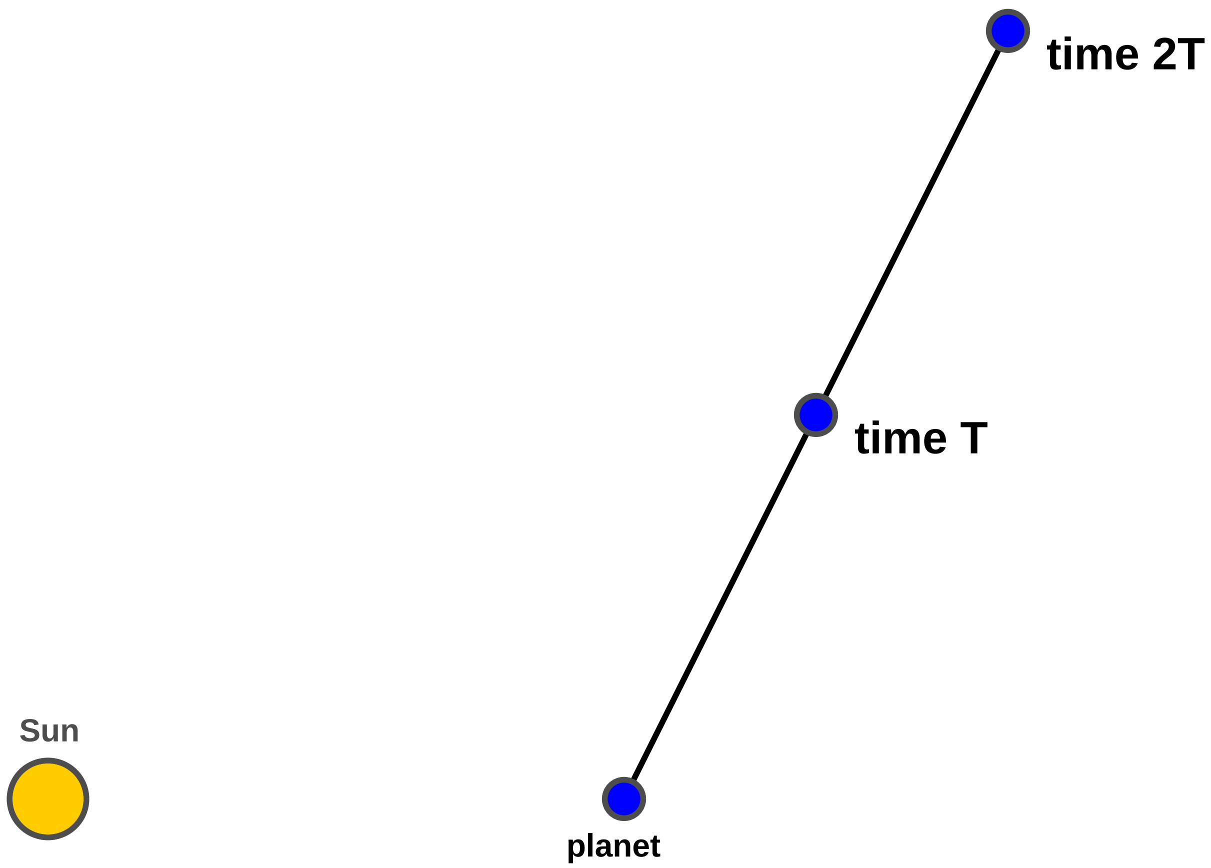
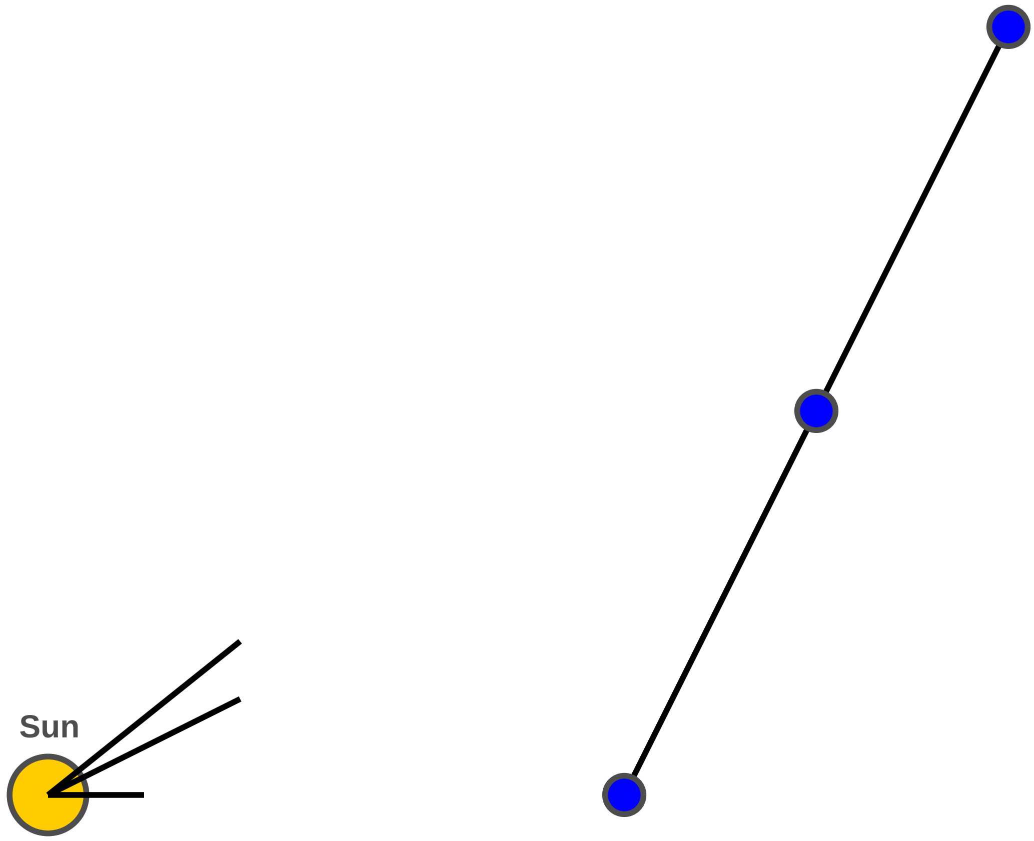


We introduce another body, ie the Sun, which will be in the center of the orbit.



Connect the points to the sun.



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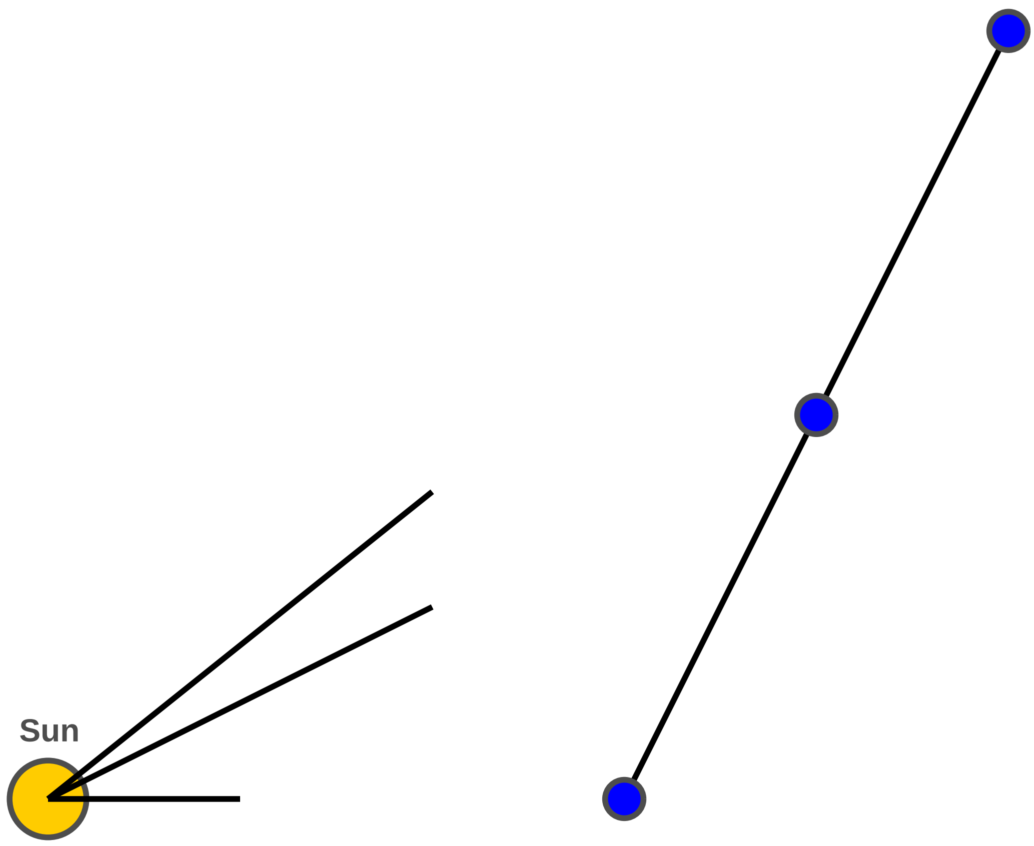

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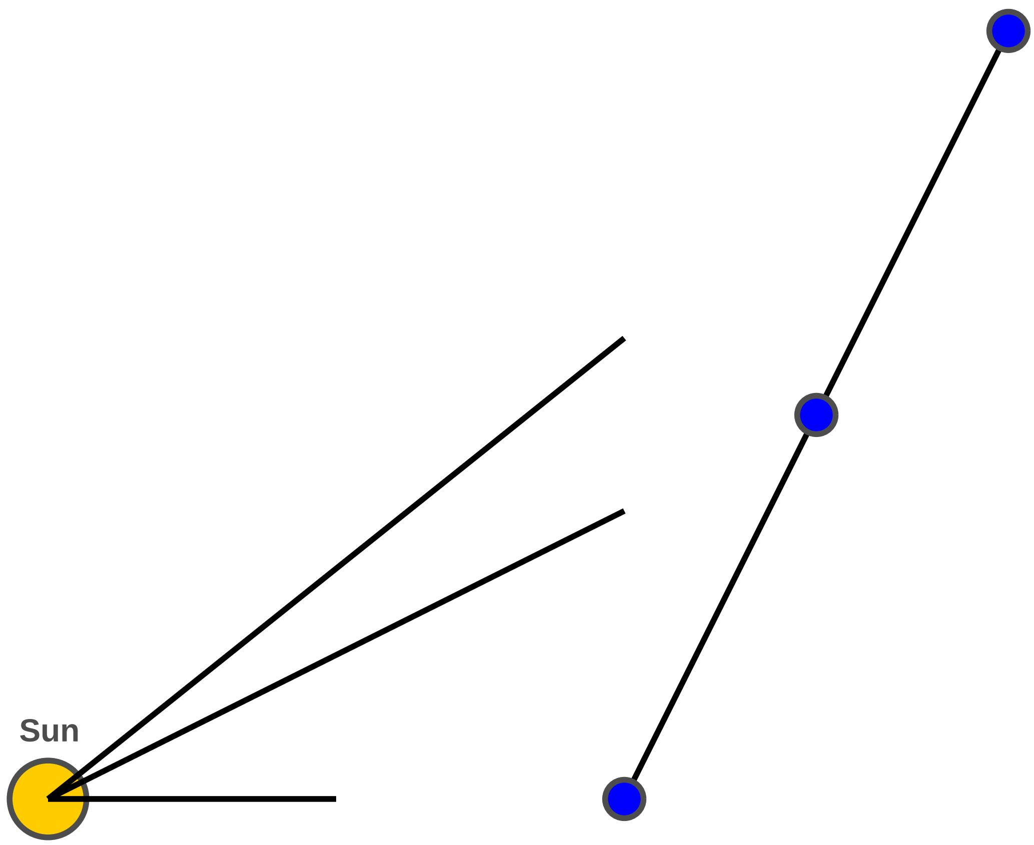

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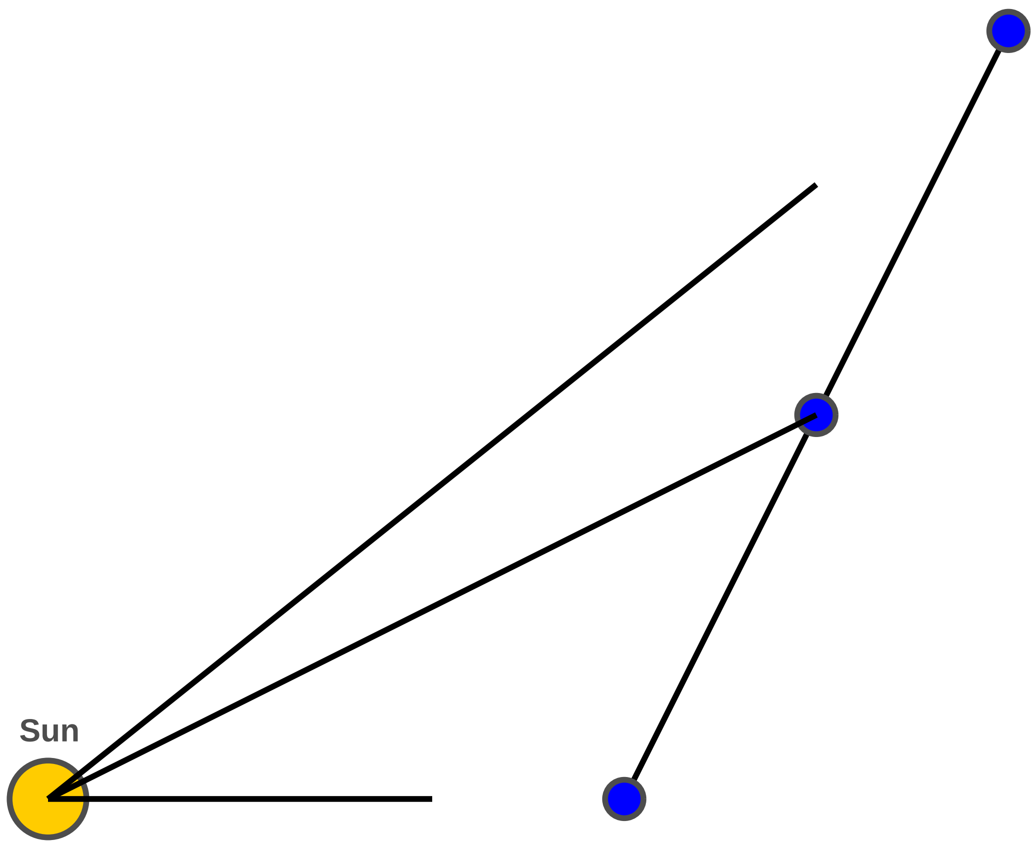

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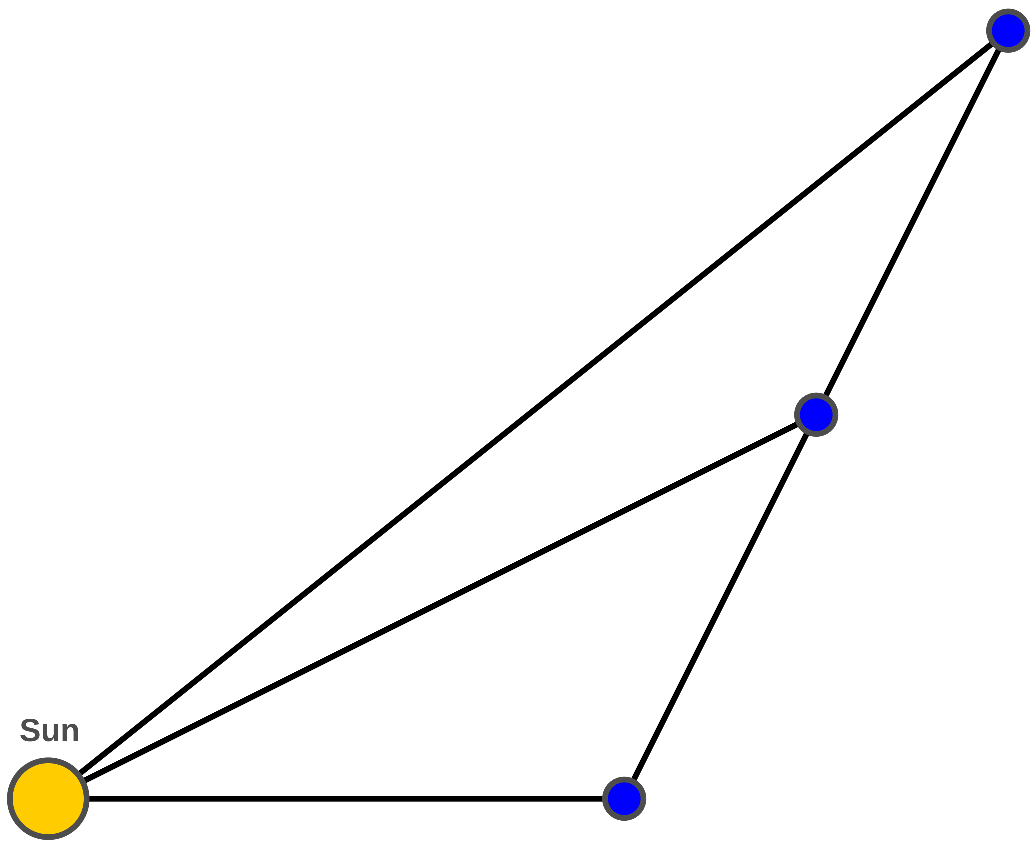
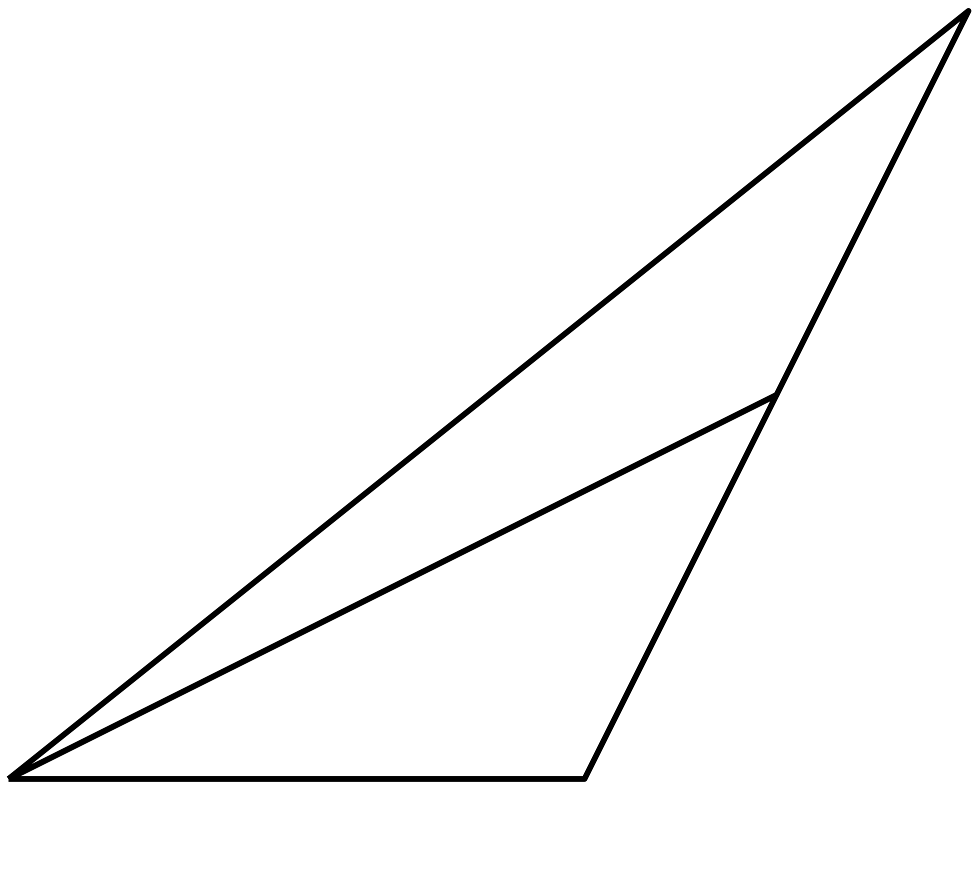
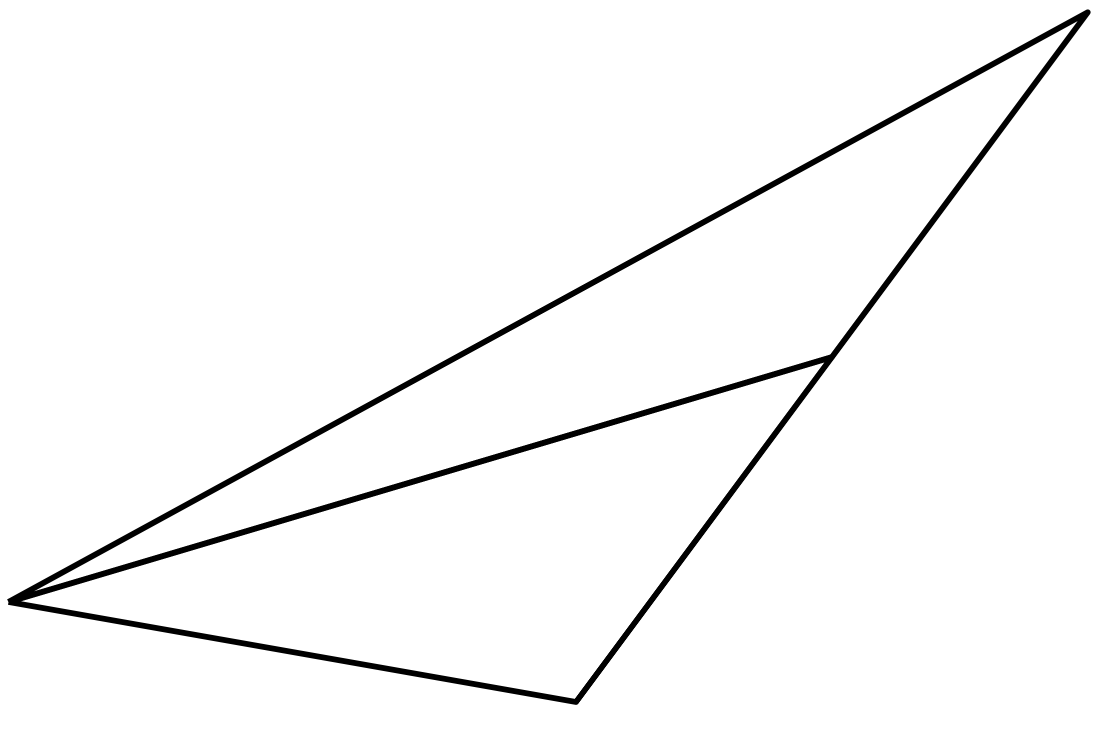
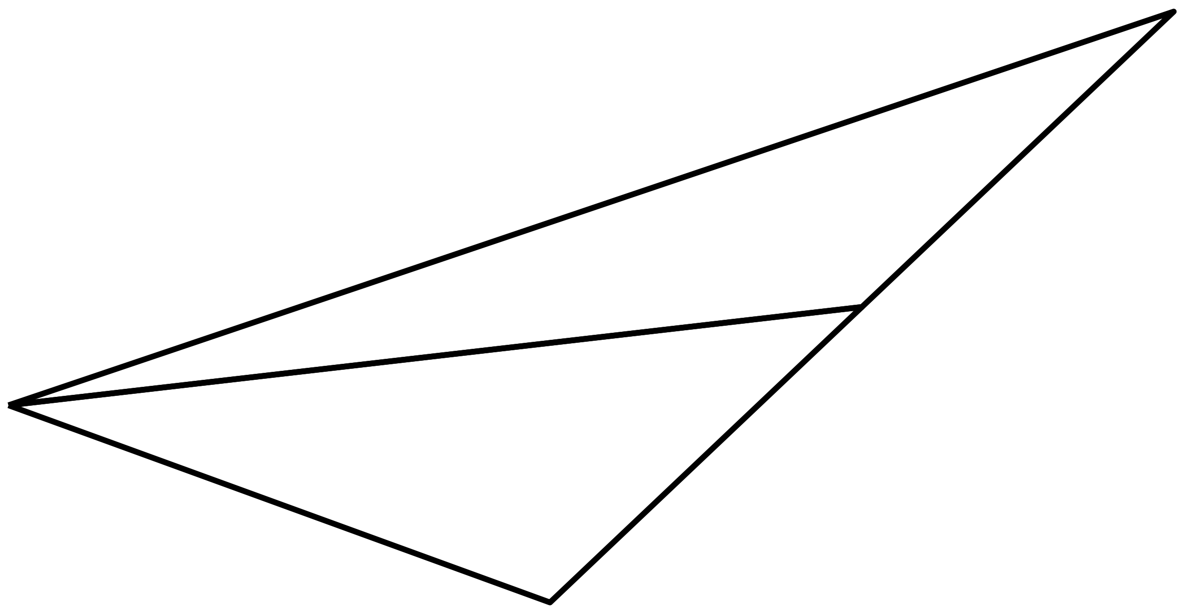
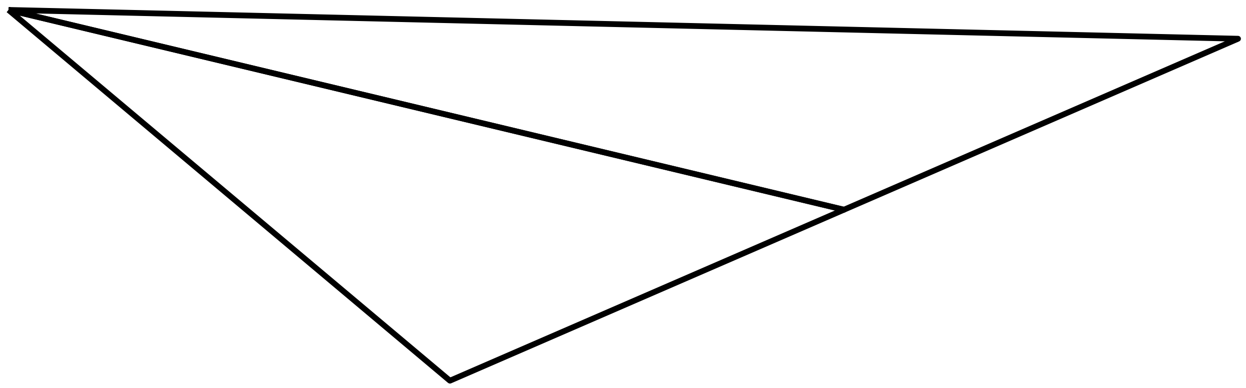


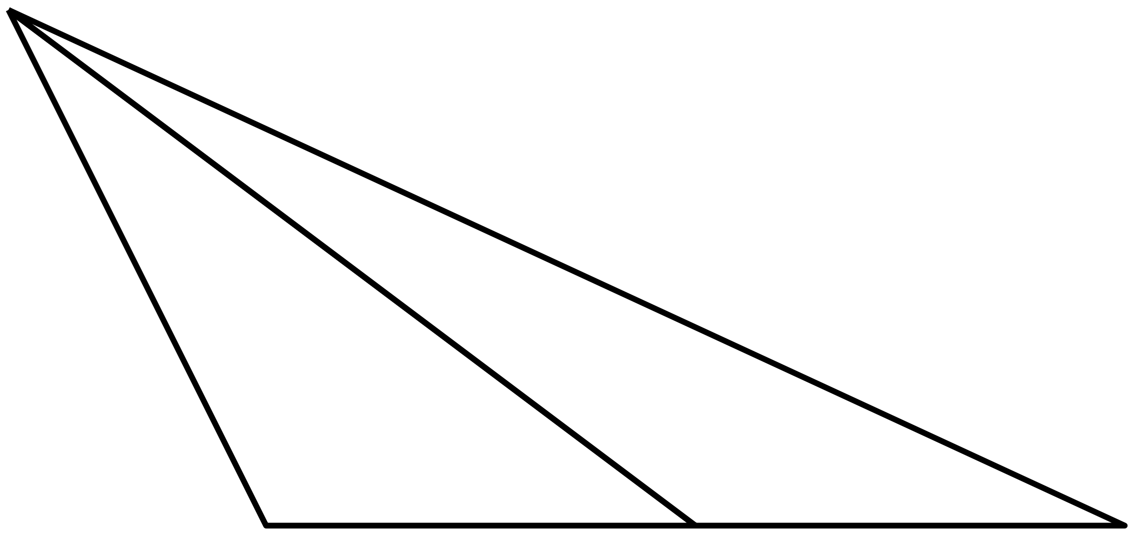
Newton's proof: Book 1 Propopsition 1 Section 2



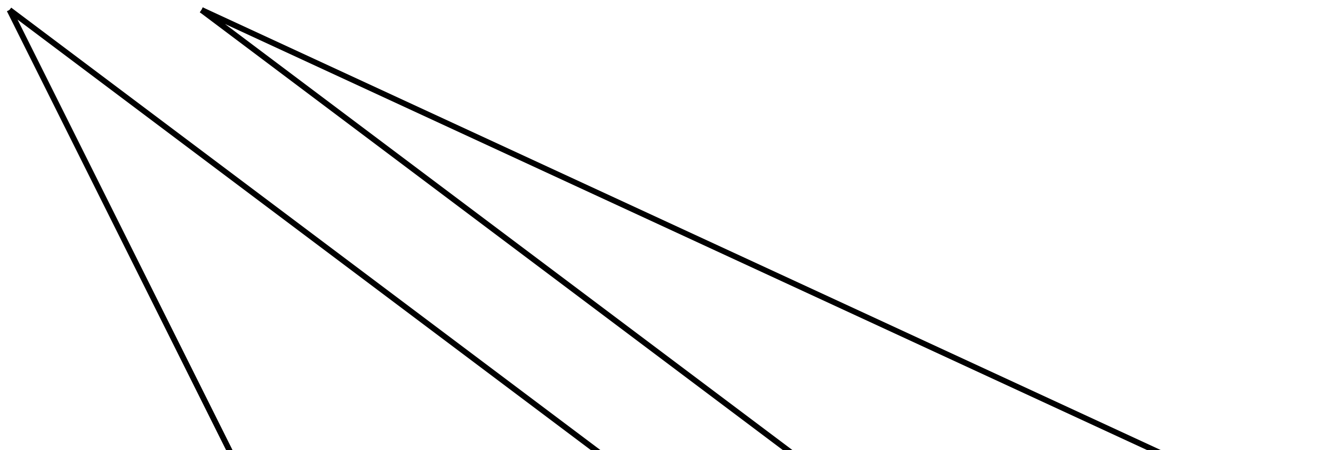




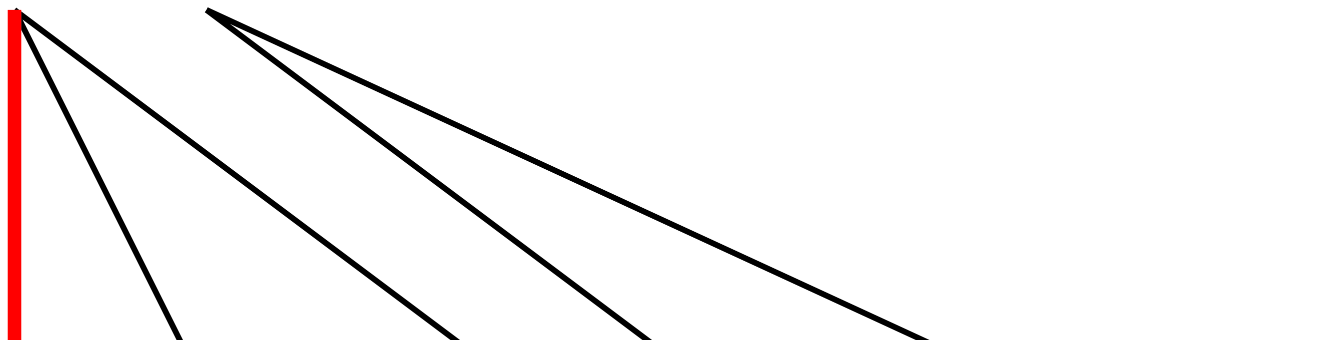




These two triangles have the same area.



They both have the same height...



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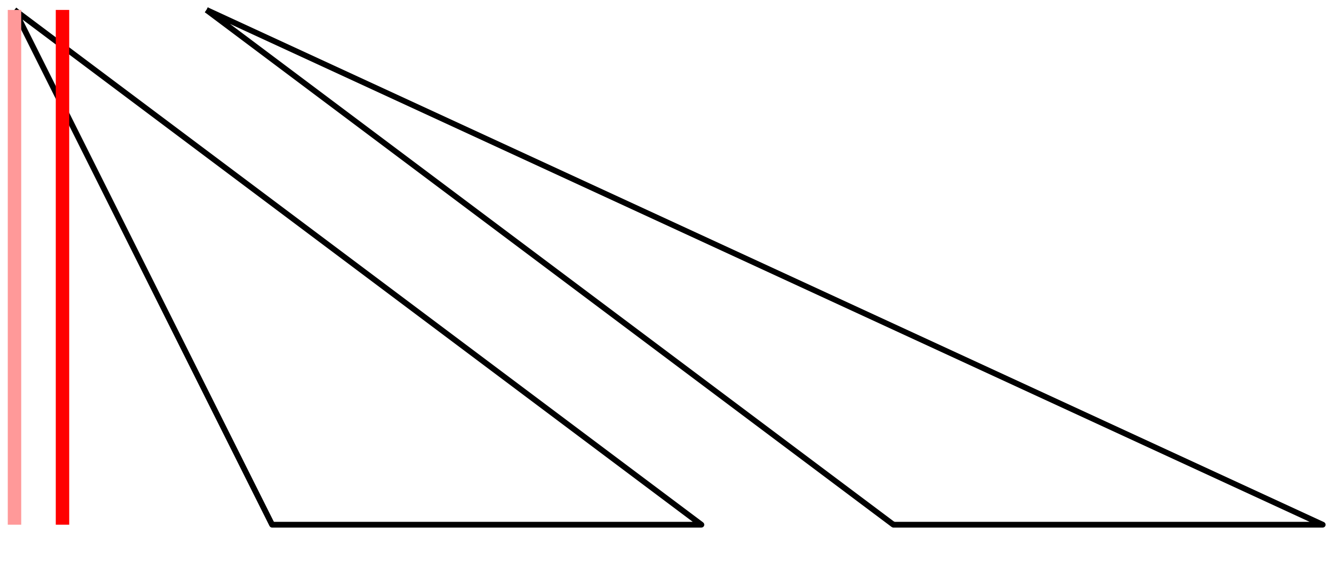

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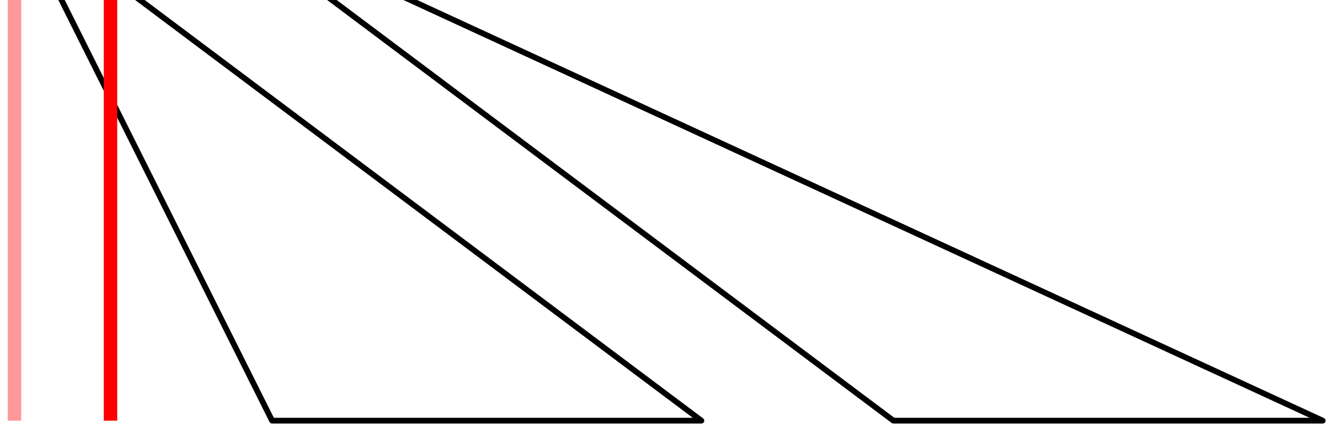

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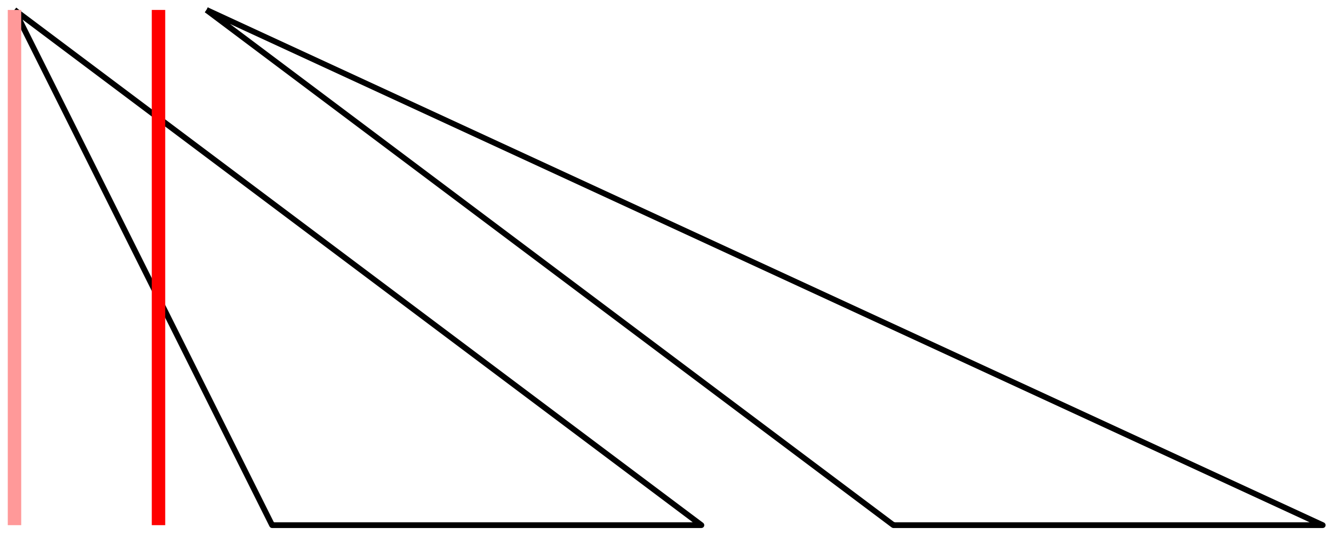

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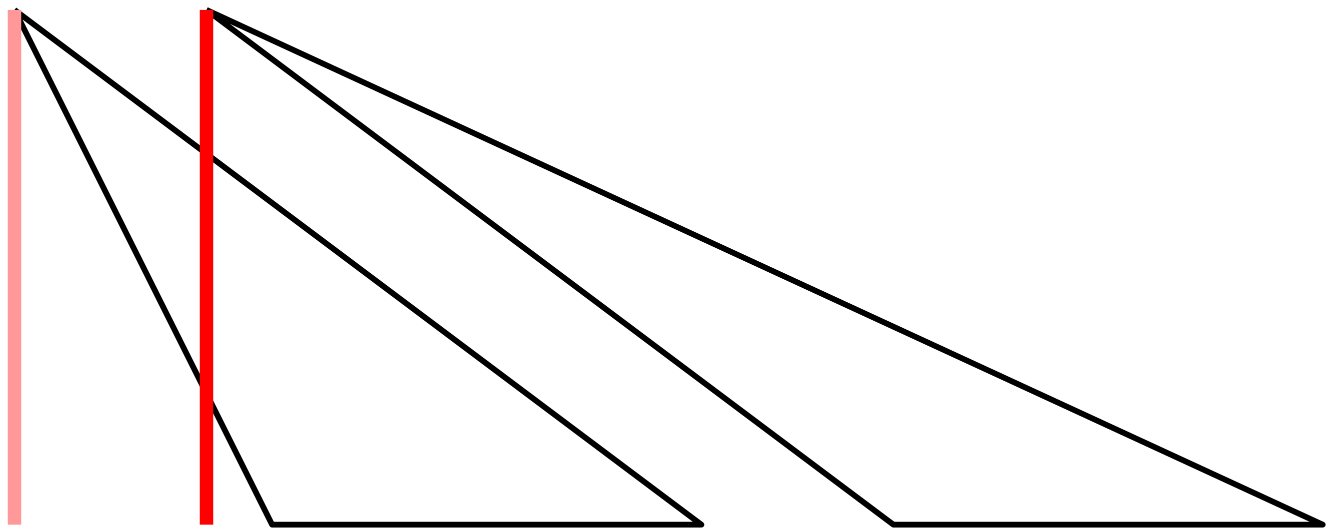

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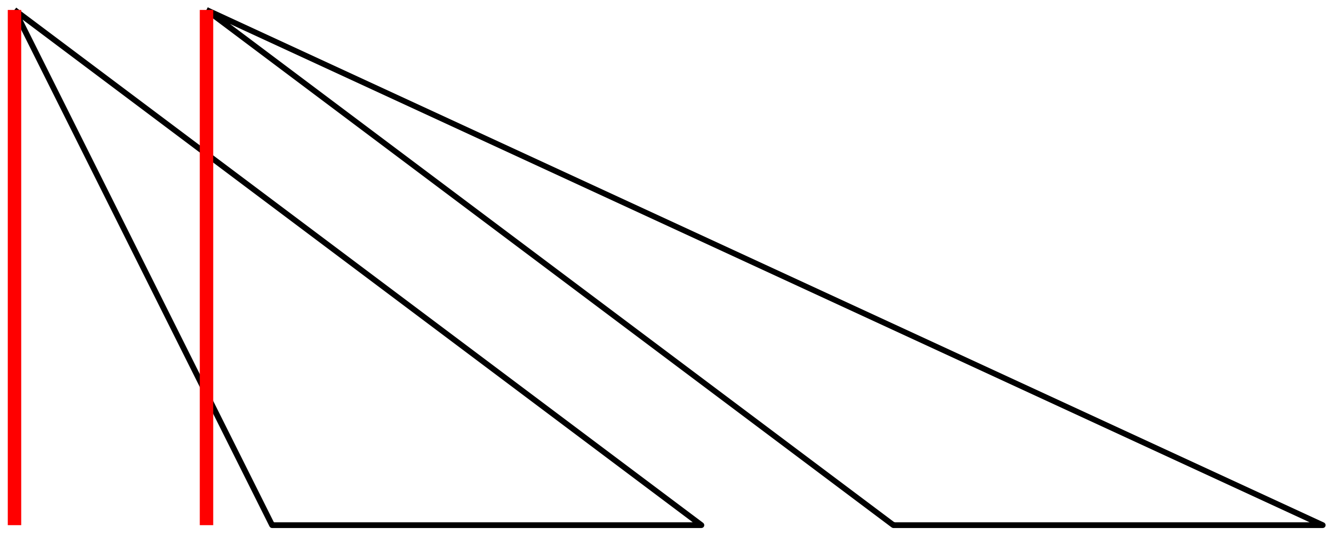
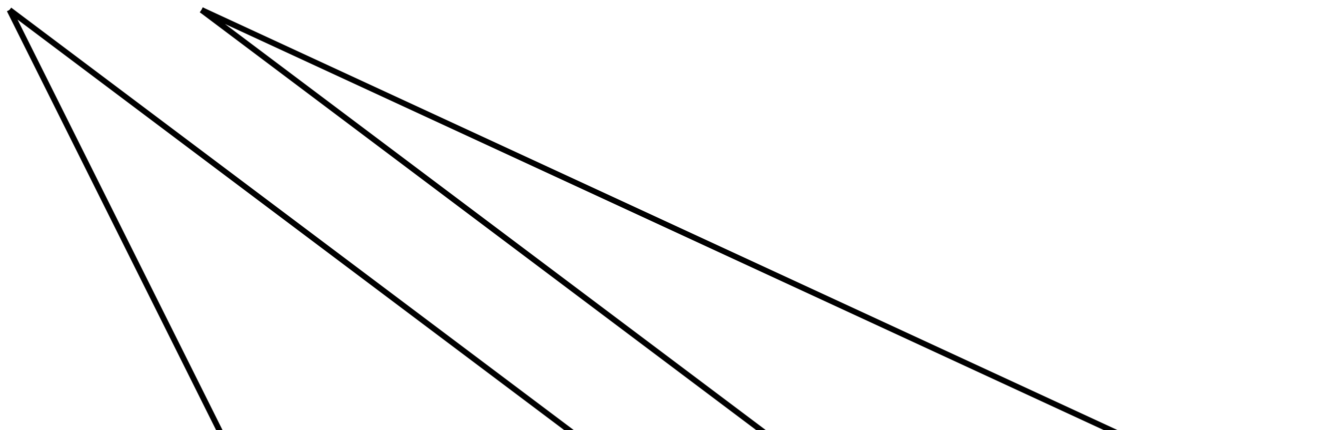


and the same base.



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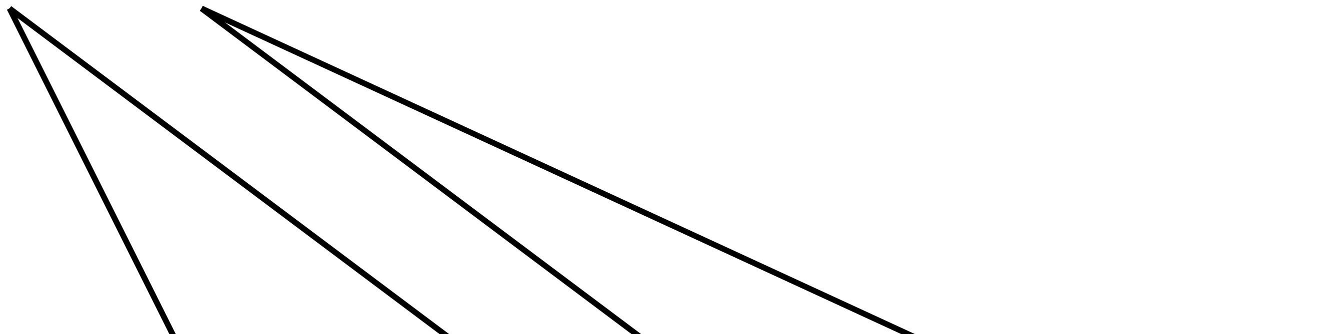

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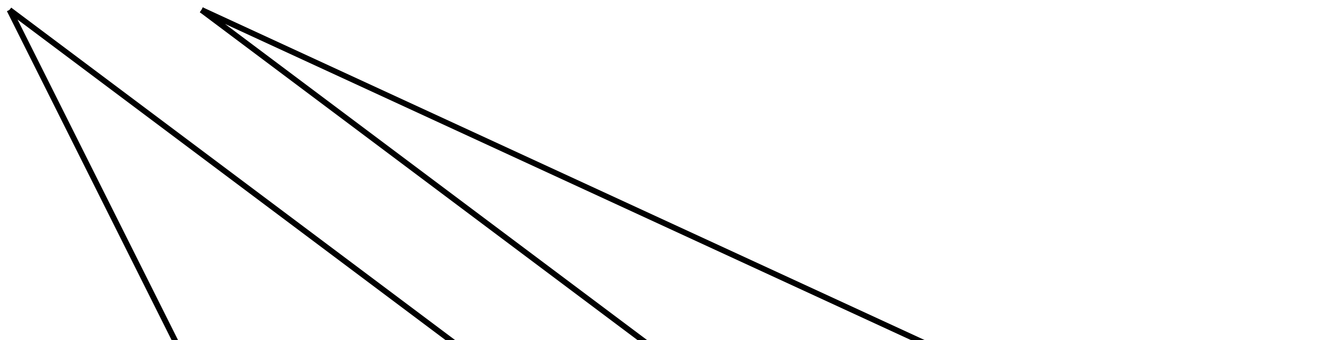

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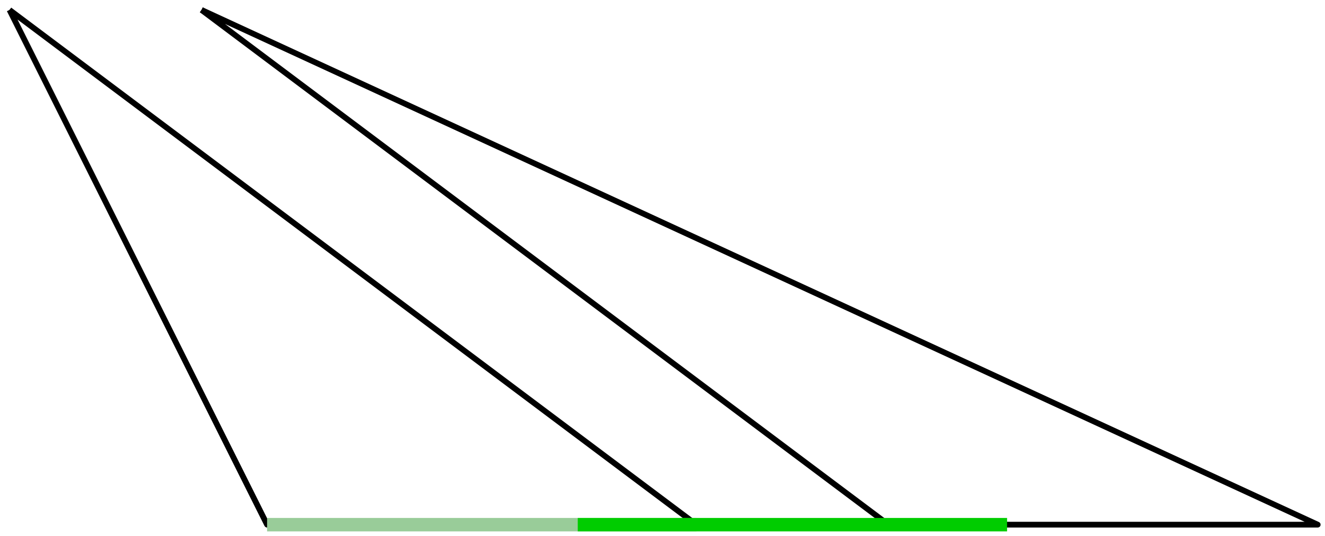

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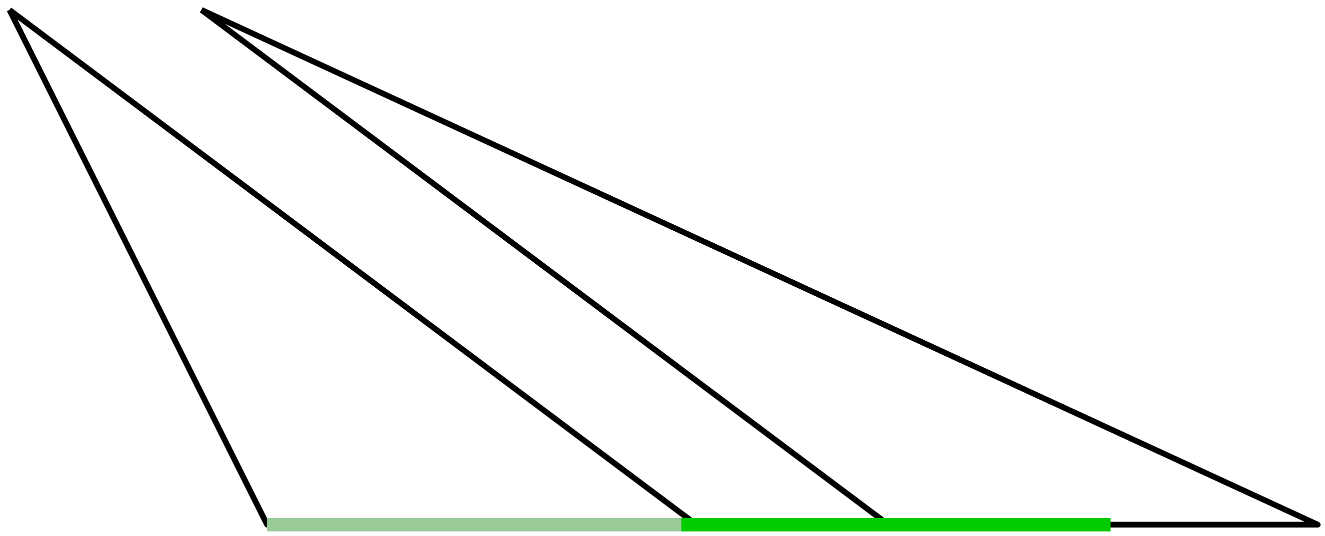

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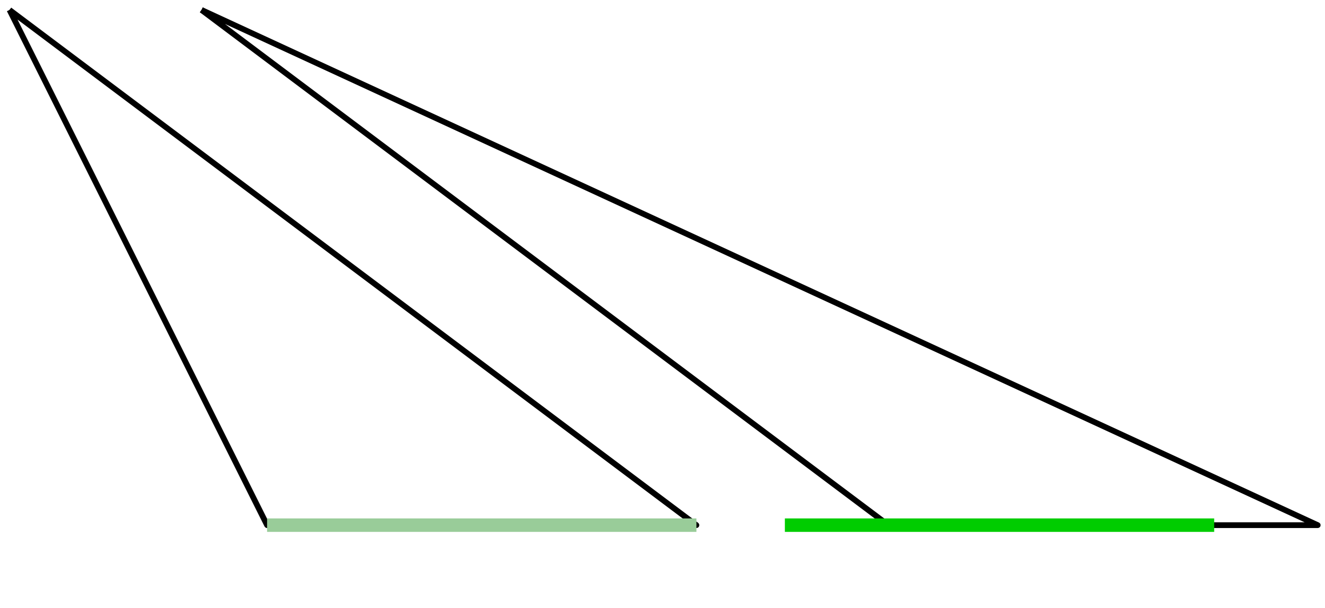

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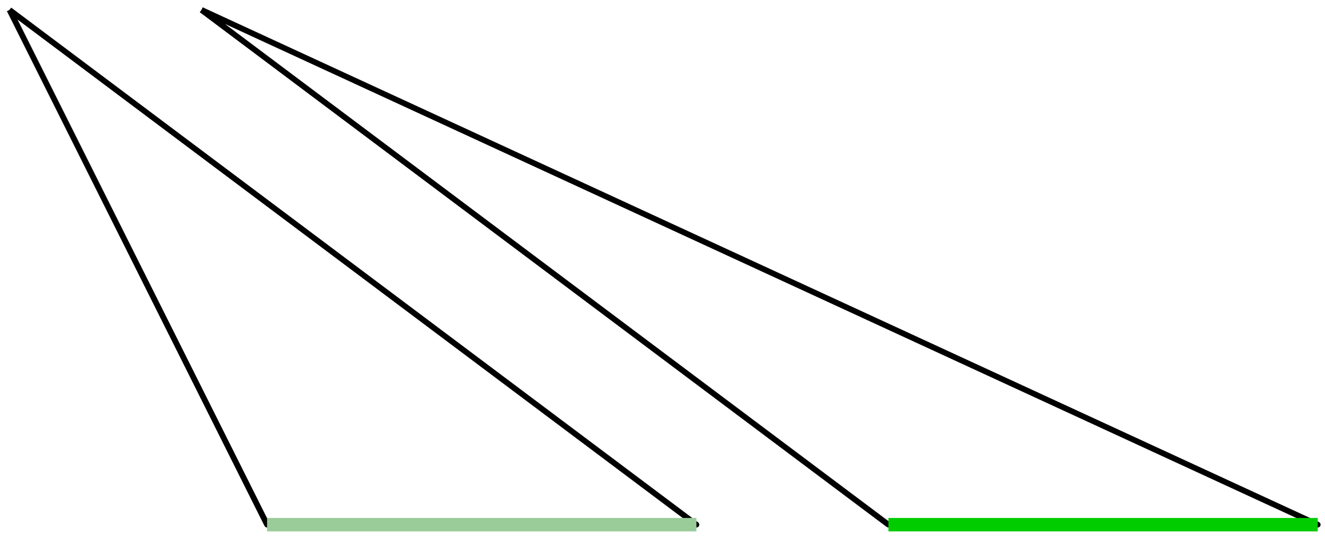

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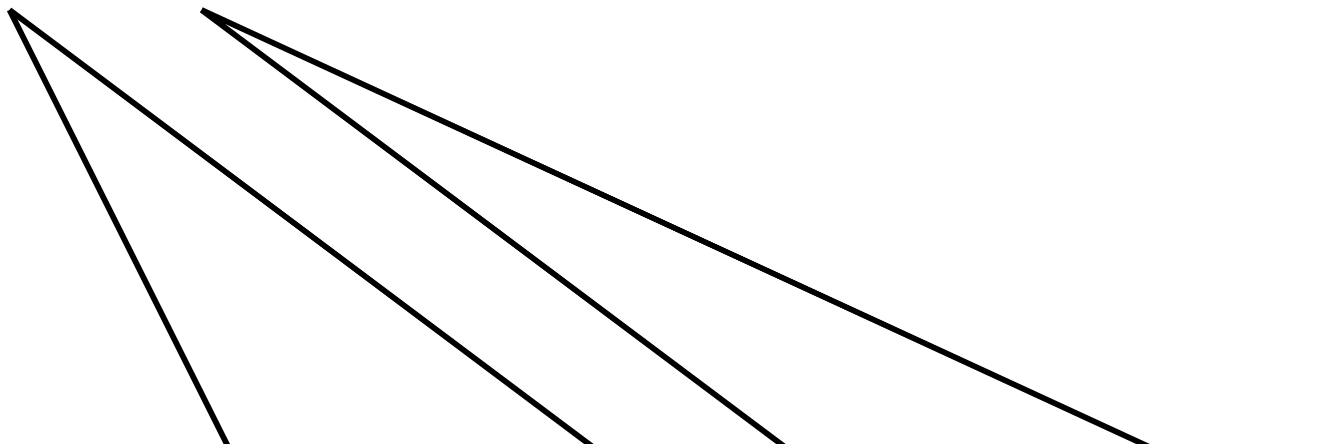
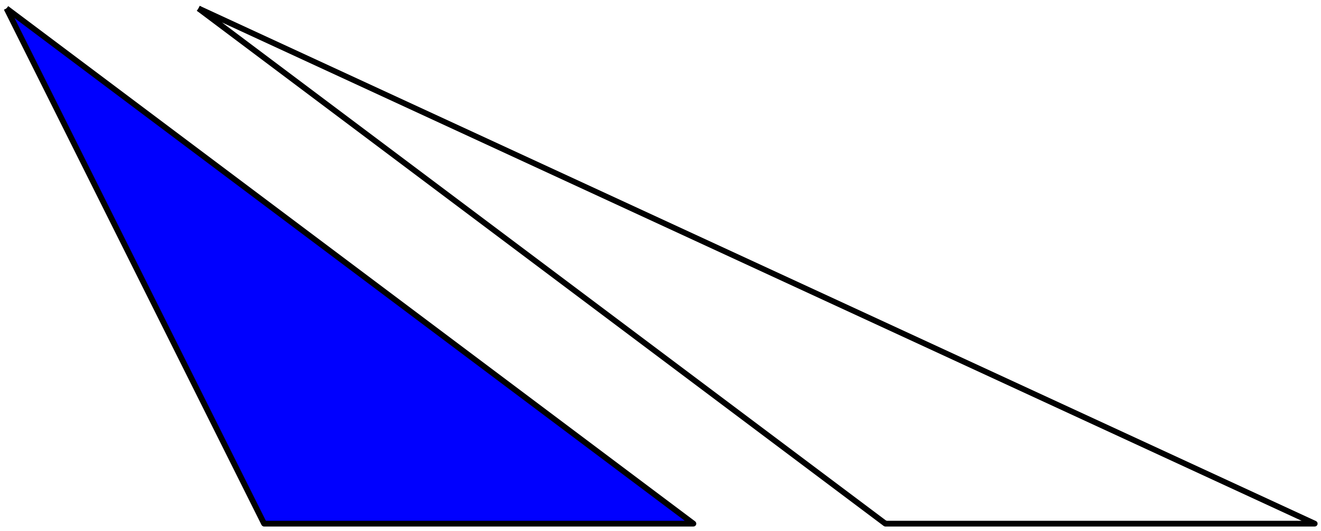


Therefore these two triangles do have the same areas.
By Euclid I.38: Triangles which are on equal bases and in the same parrallels equal one another.



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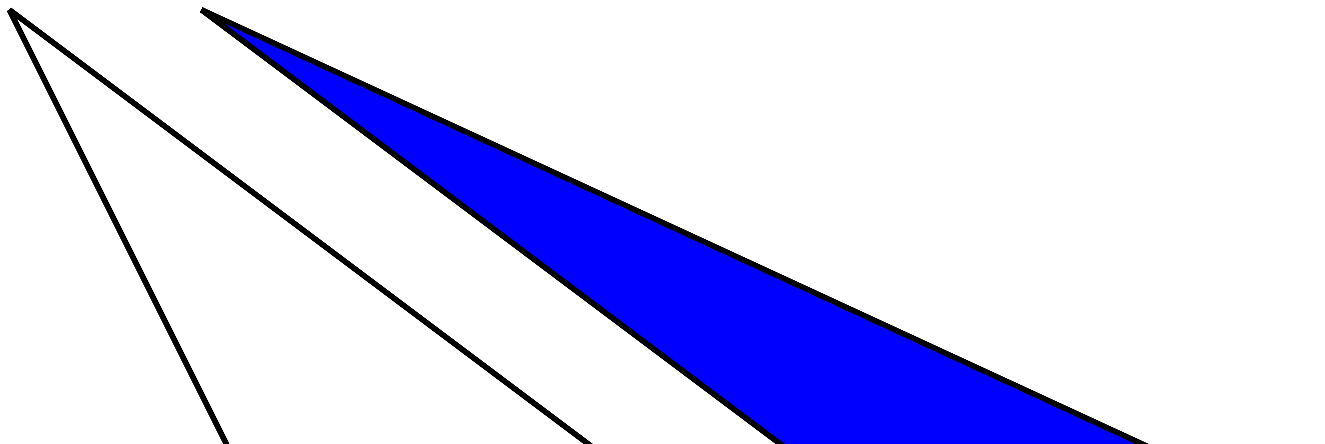

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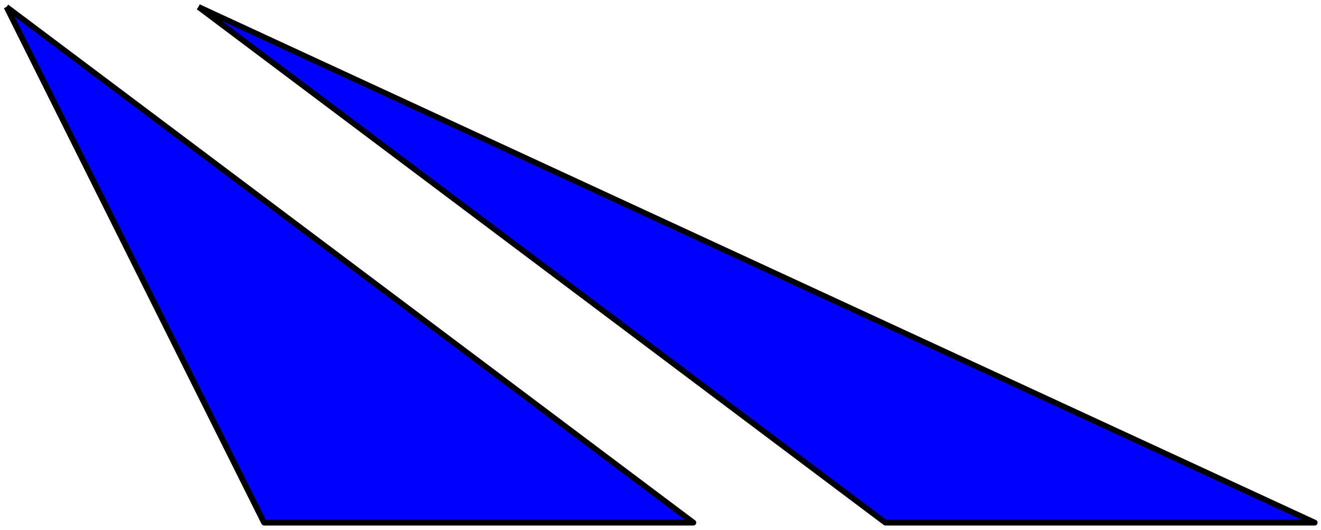
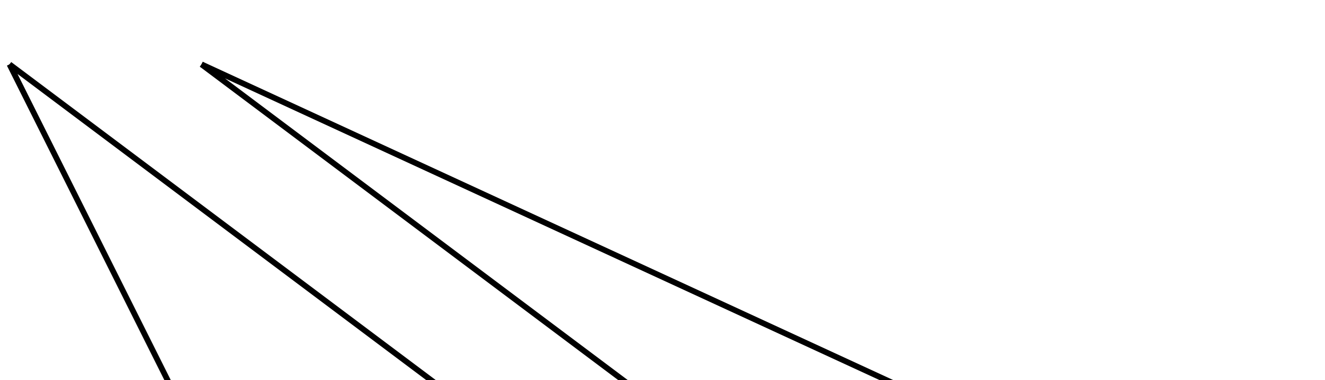
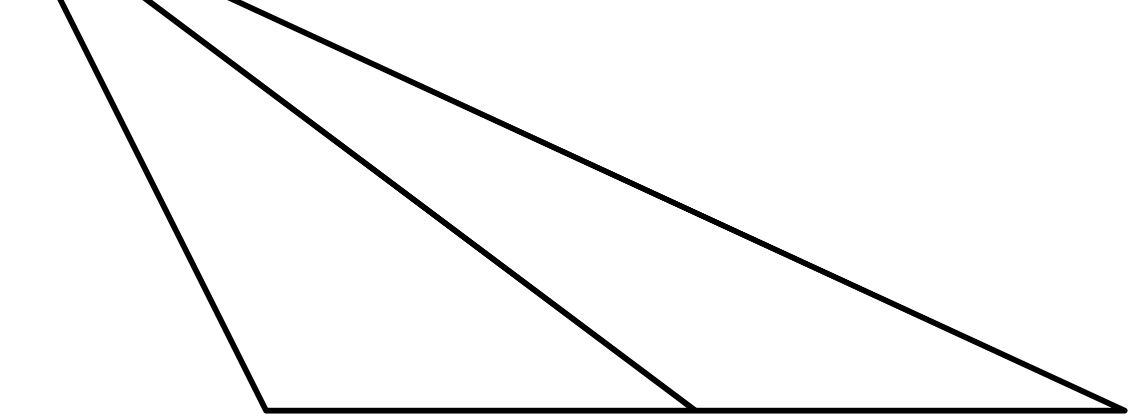
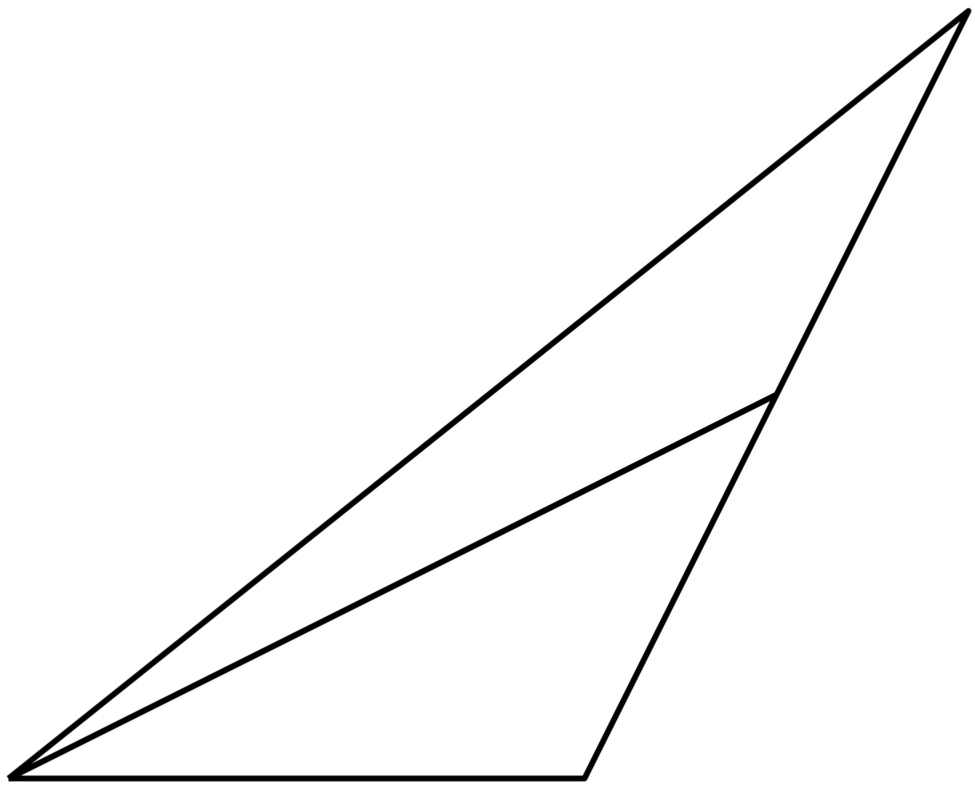
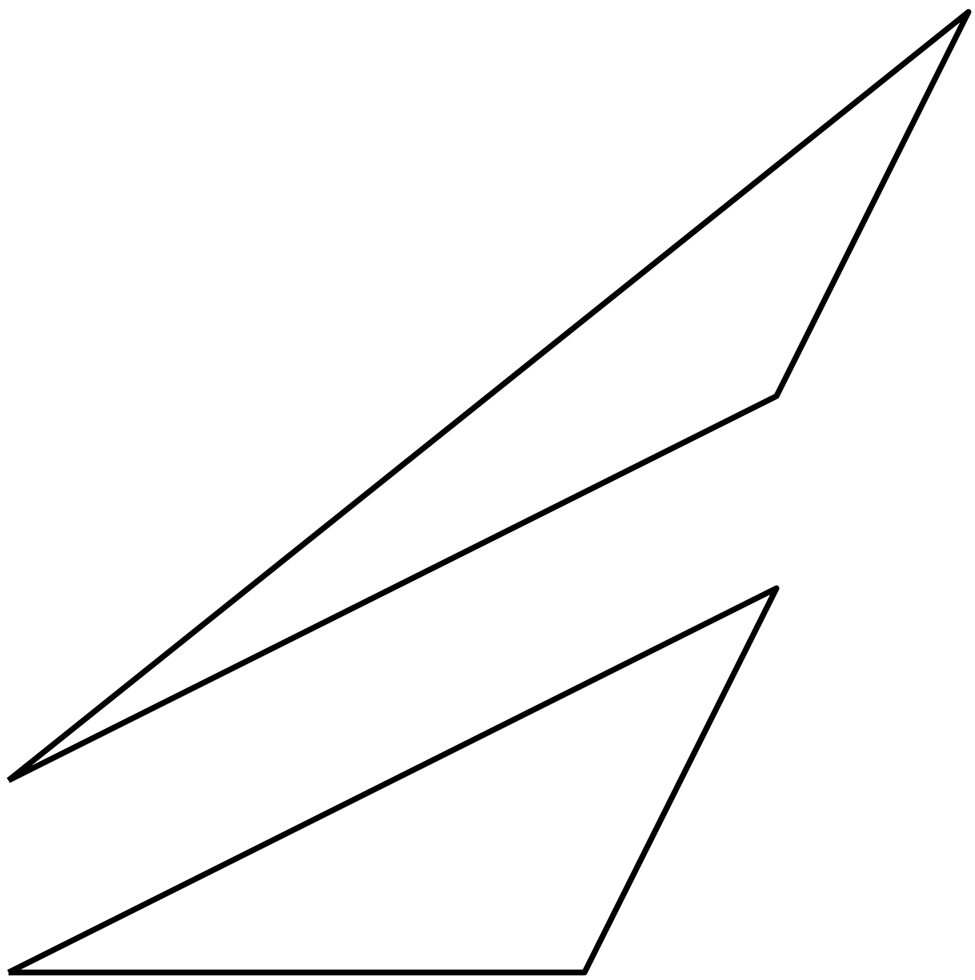
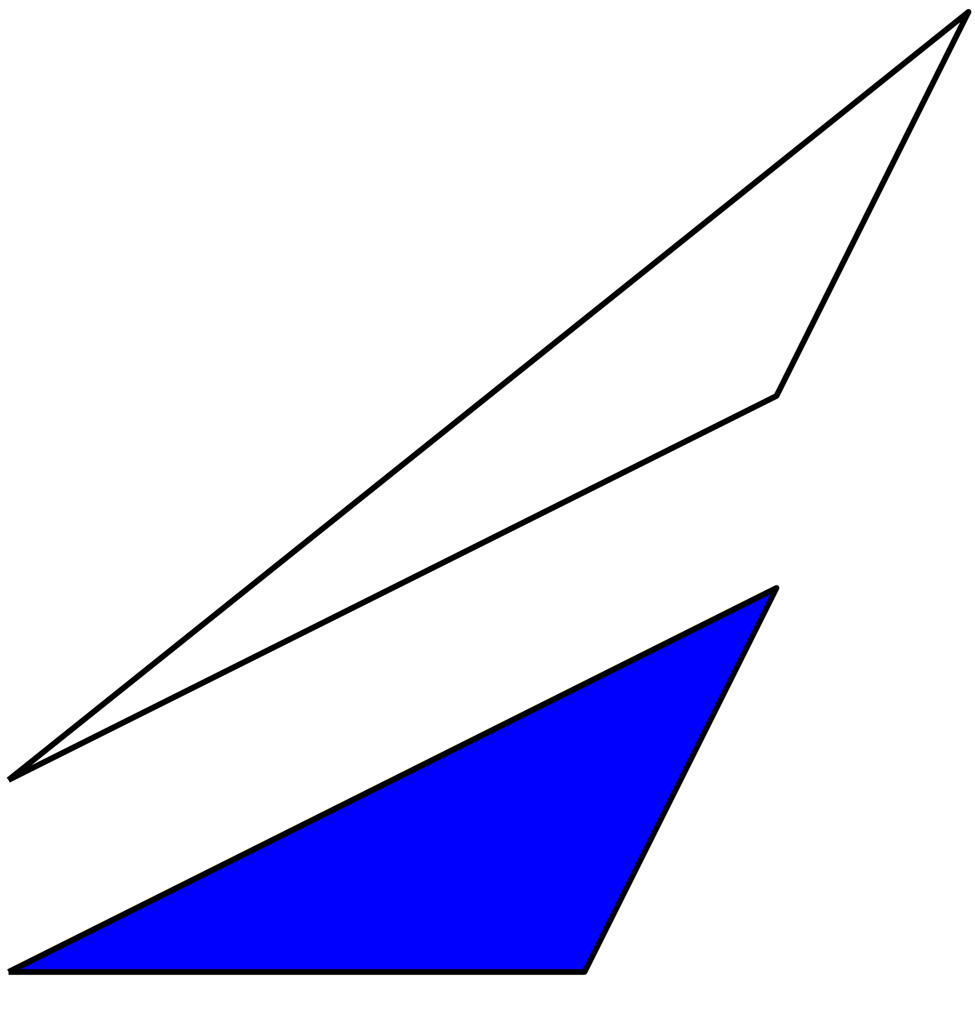


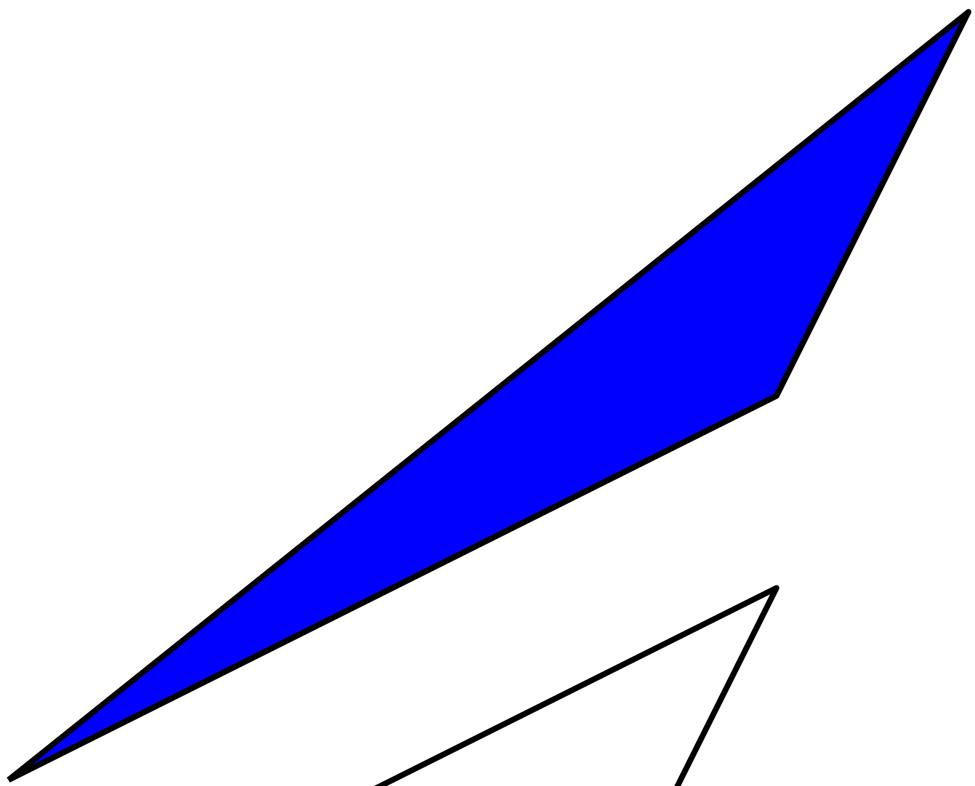


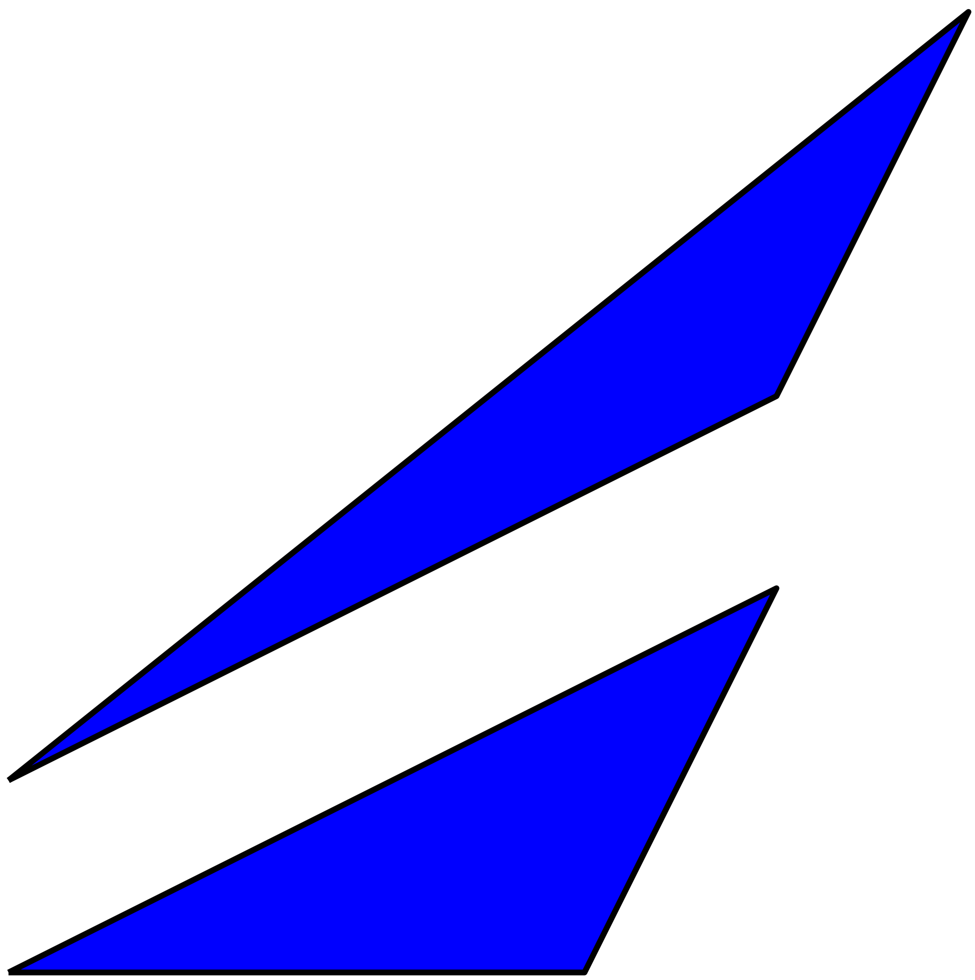


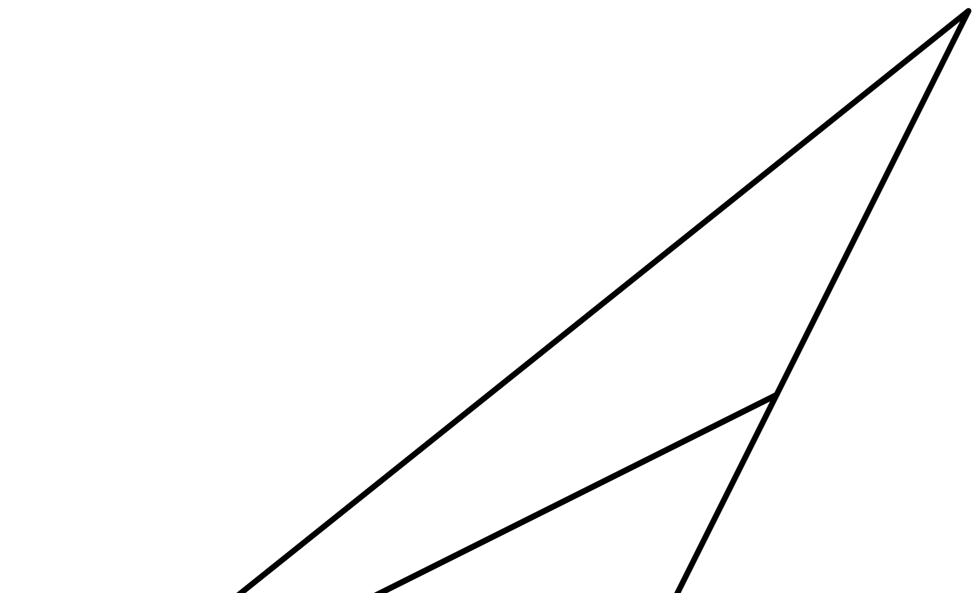




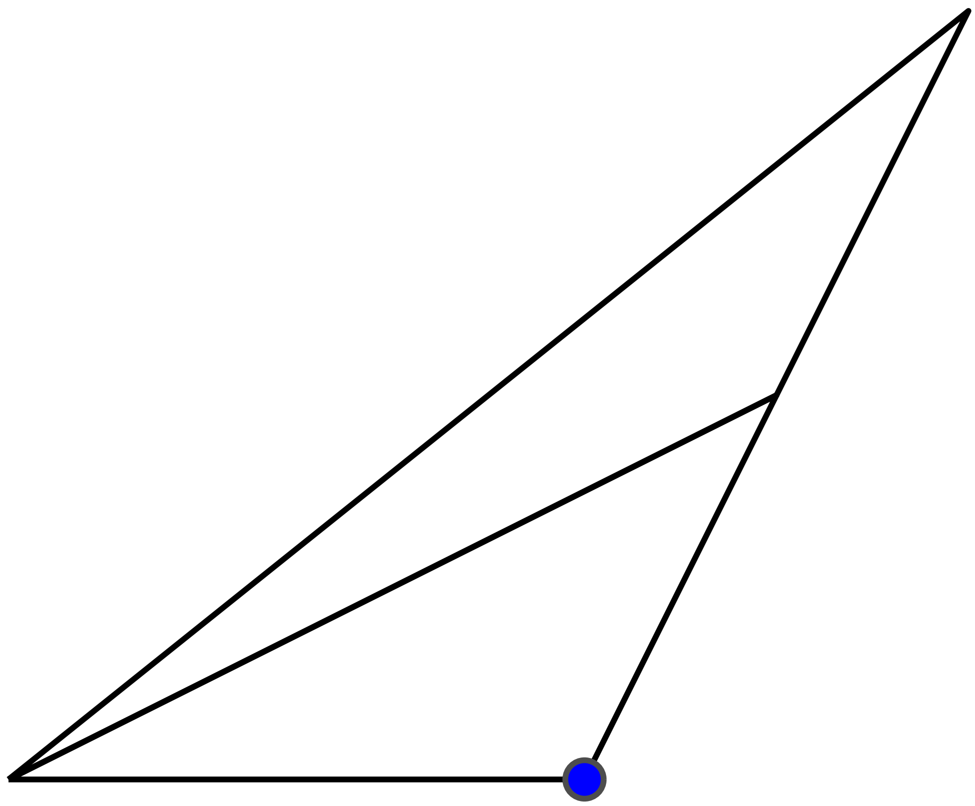




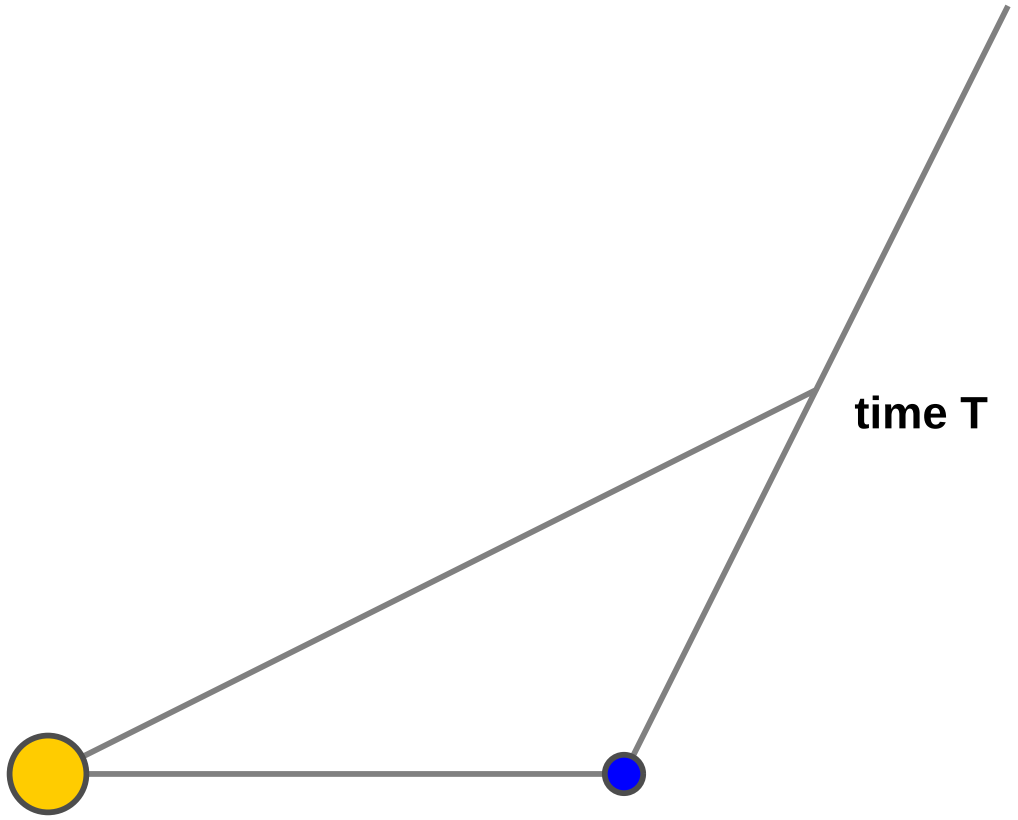




If there are no other forces acting on the planet the planet will go in a straight line.



However the sun exerts a force on the planet. This force pulls the planet towards the sun and is called the <u>centripetal force</u>.



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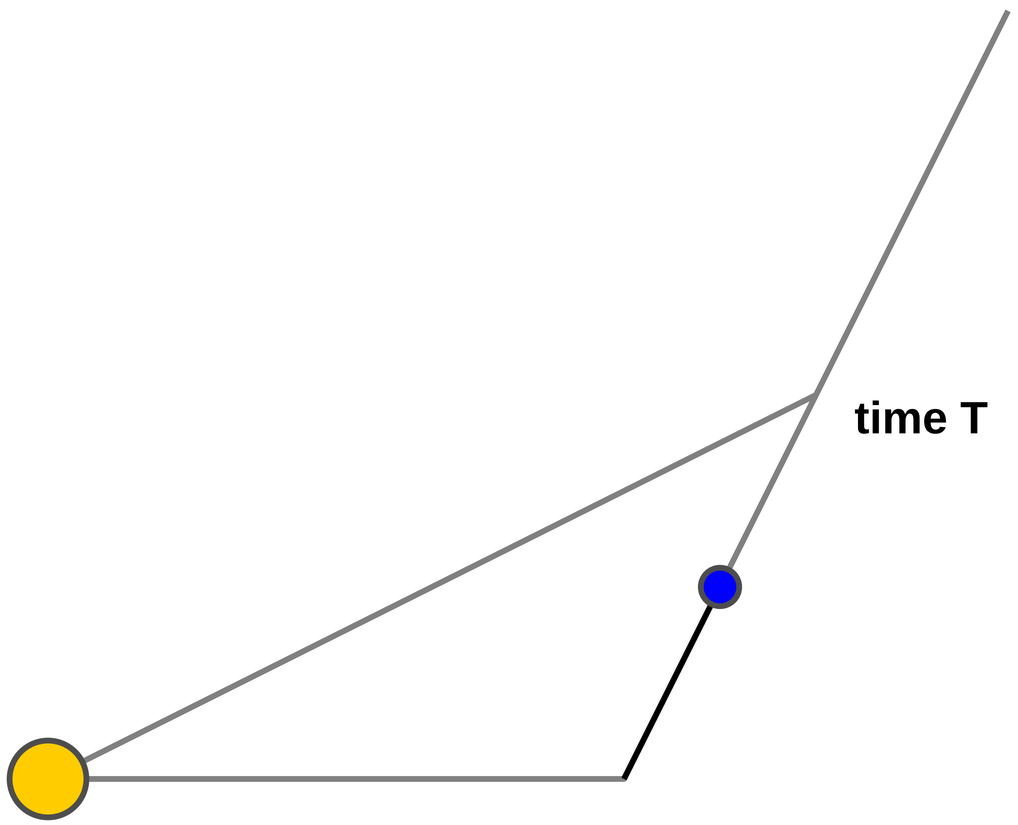

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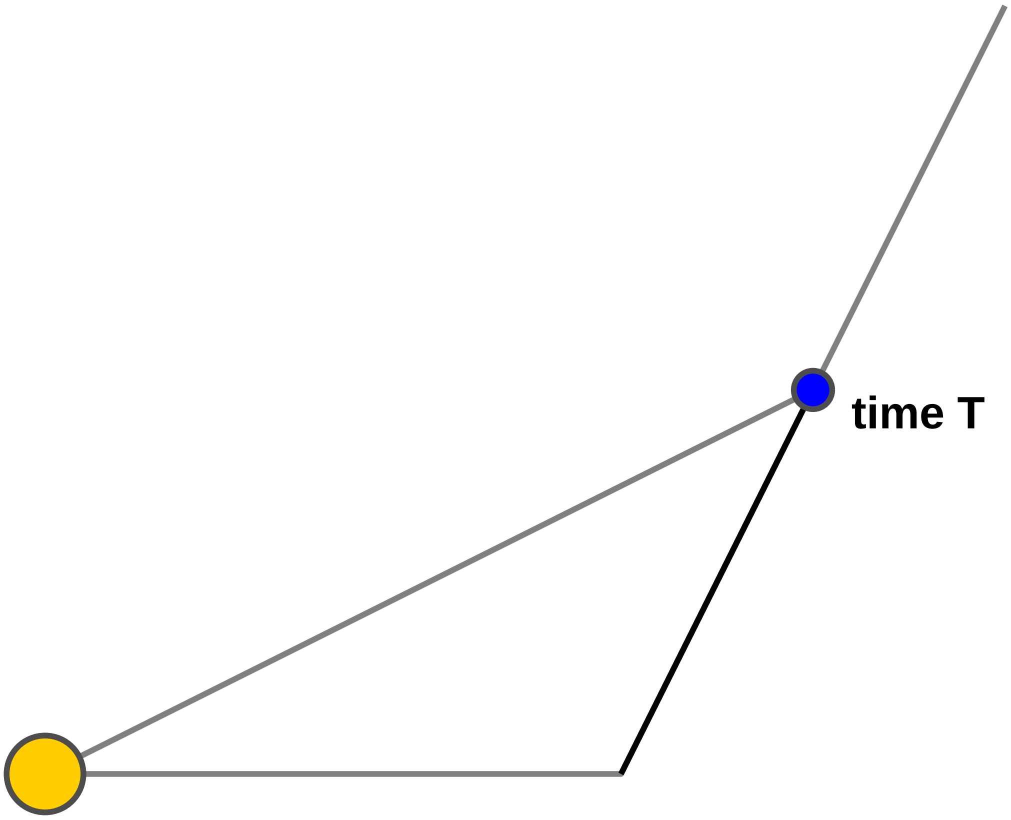

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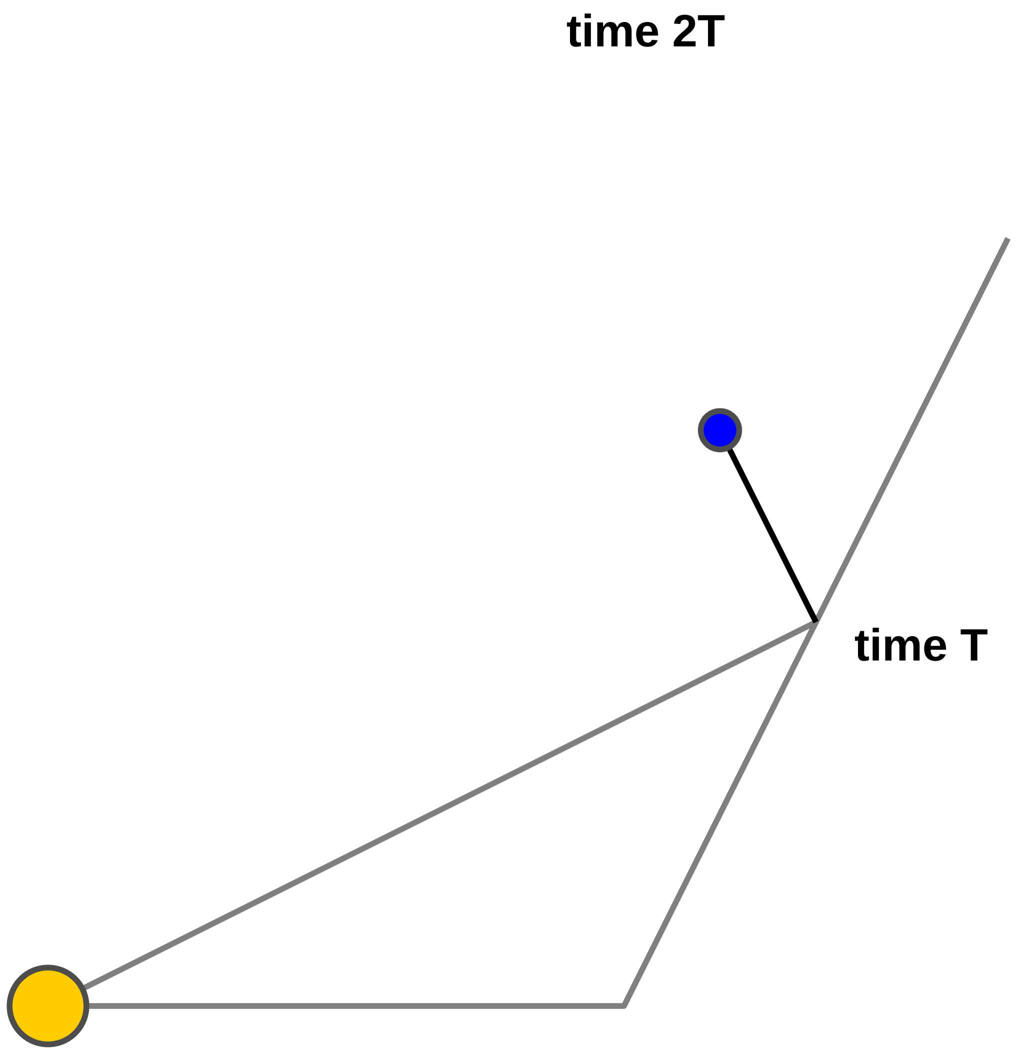

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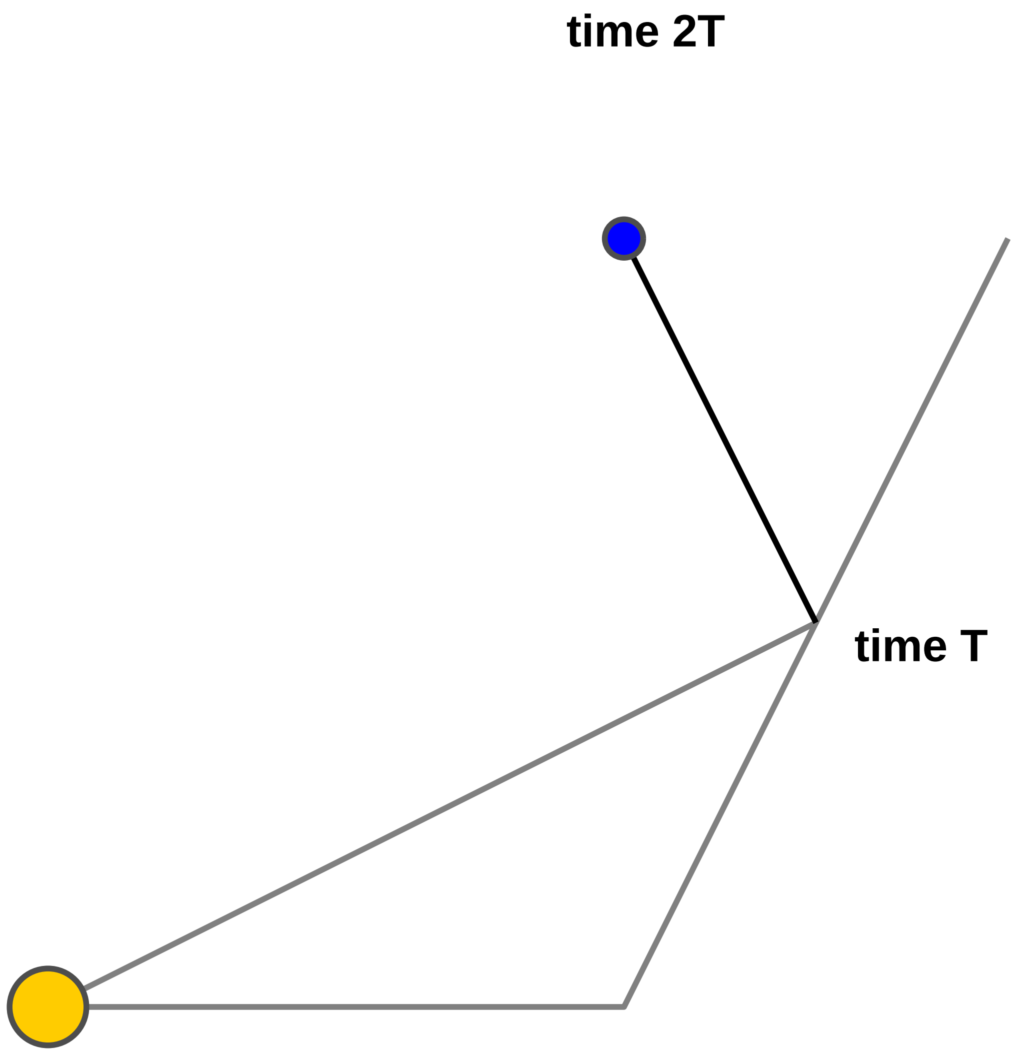

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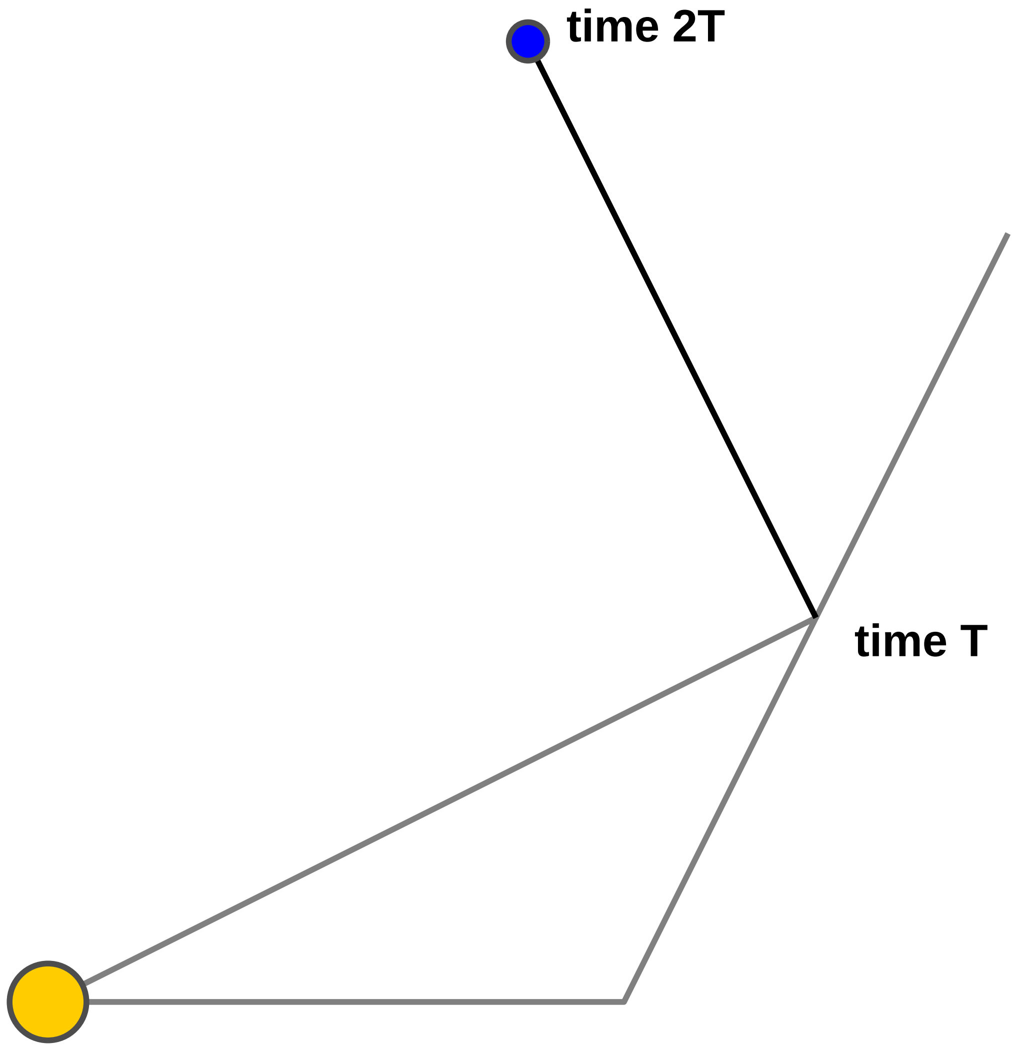
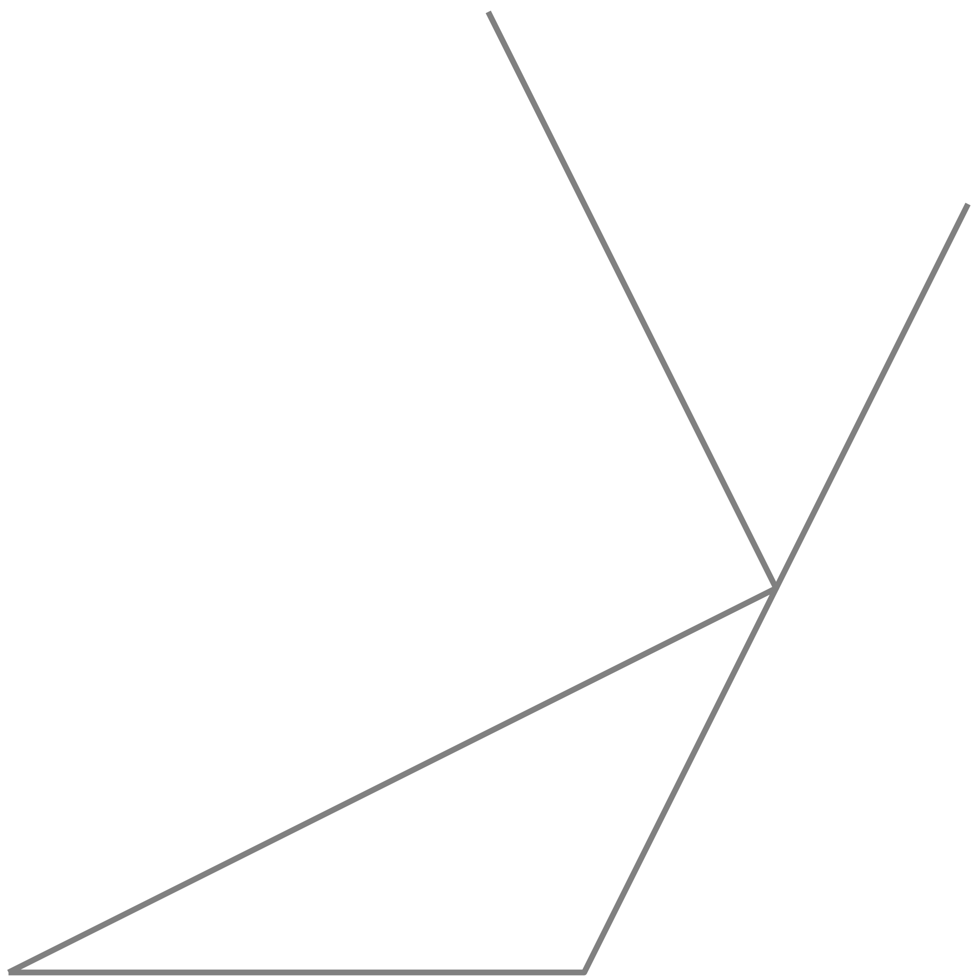
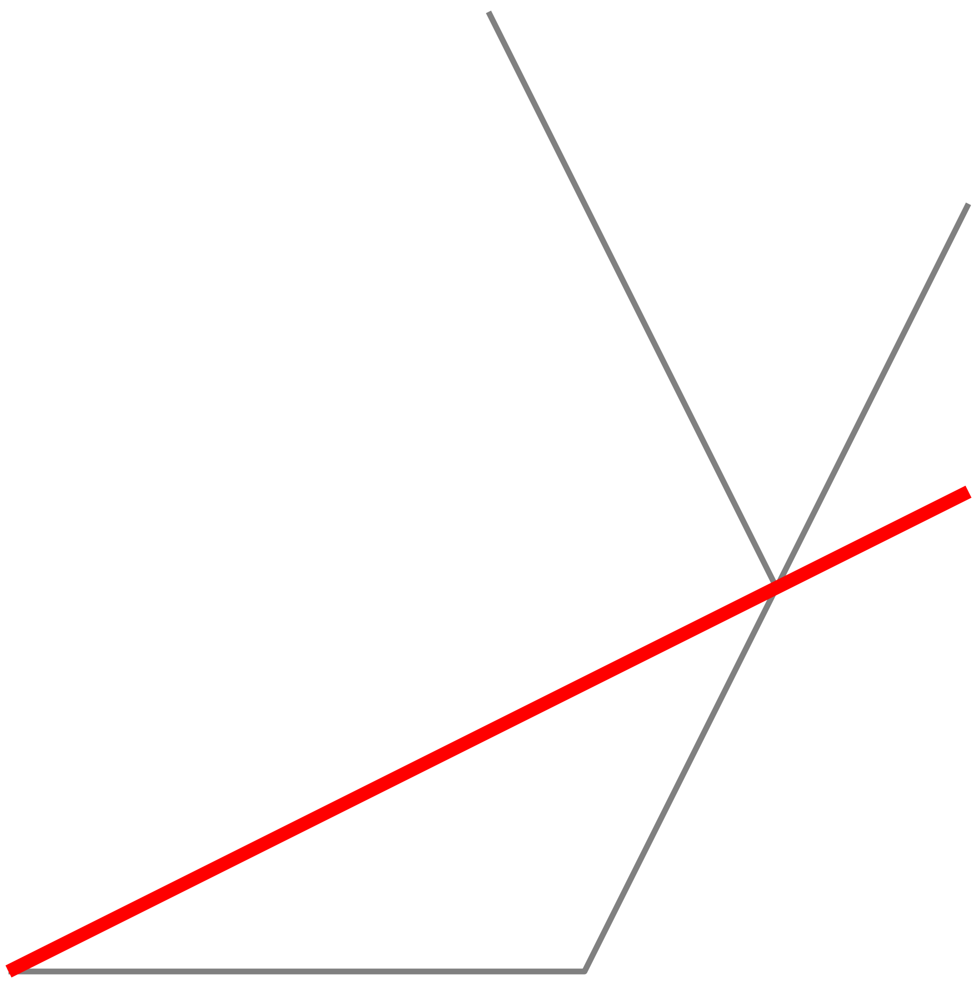




If you draw a line parallel to the one connected to the sun...



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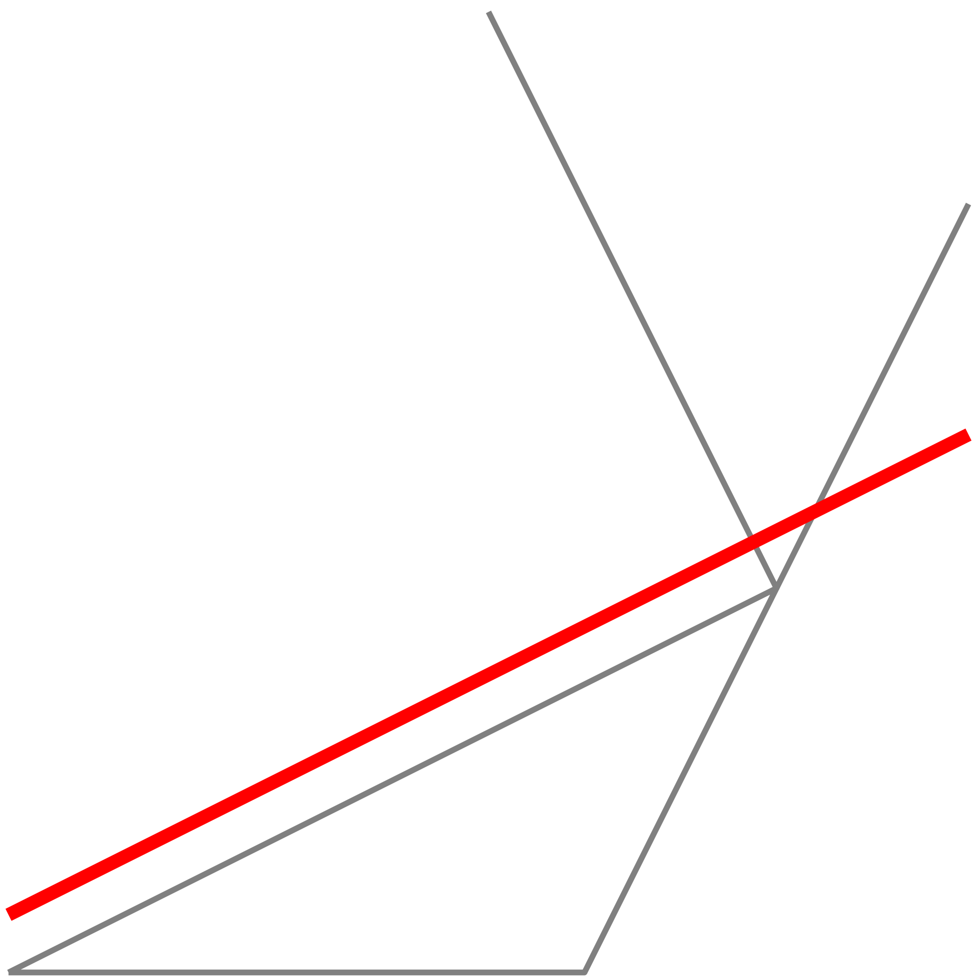

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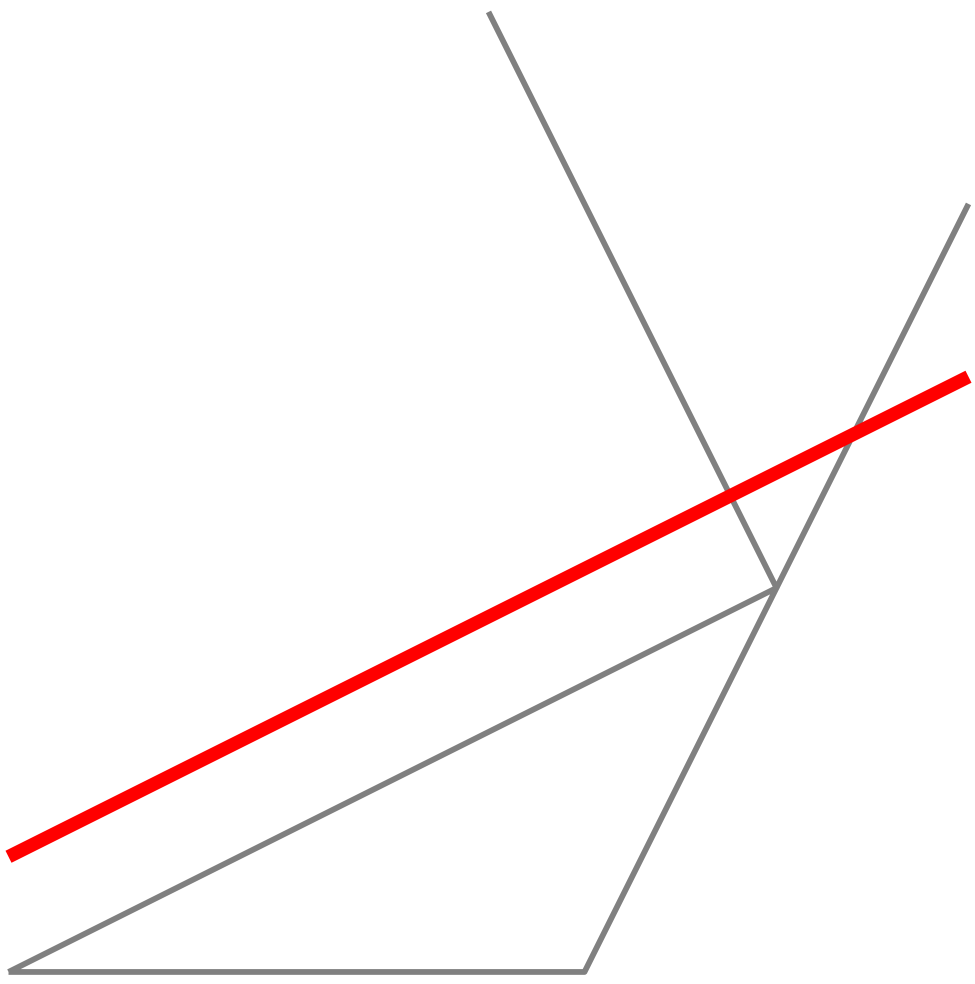

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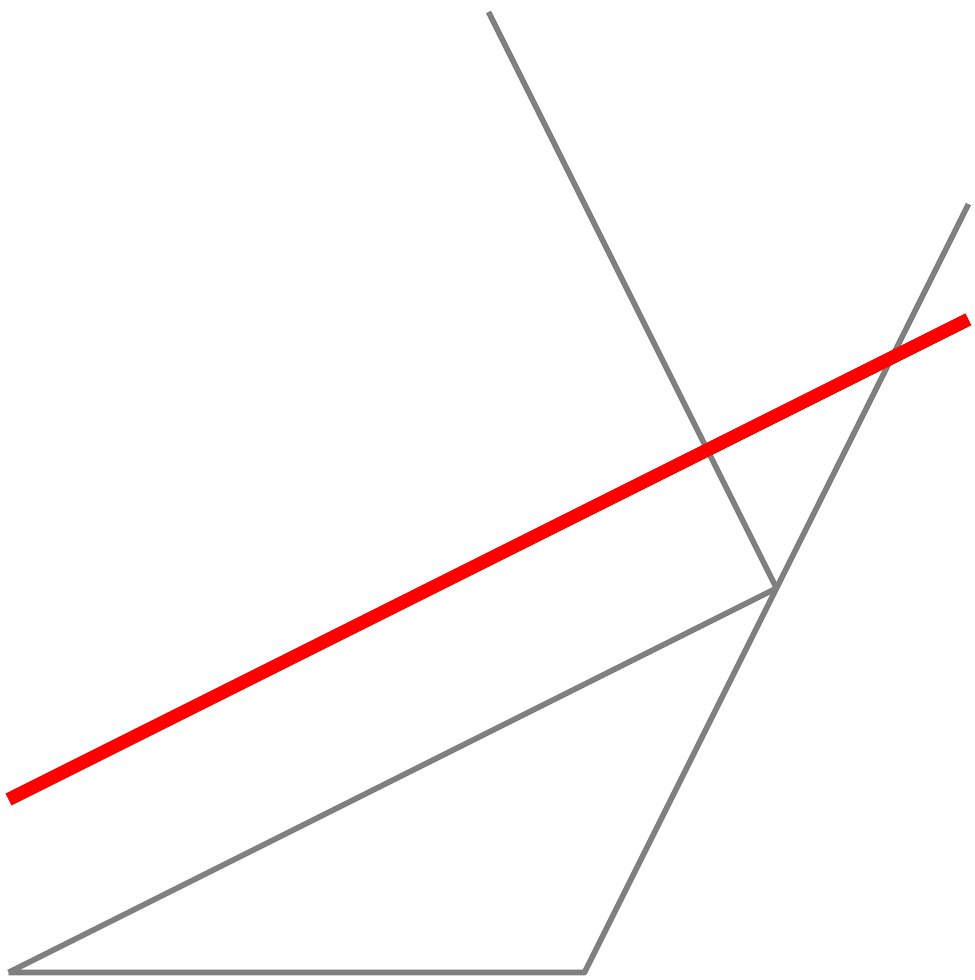

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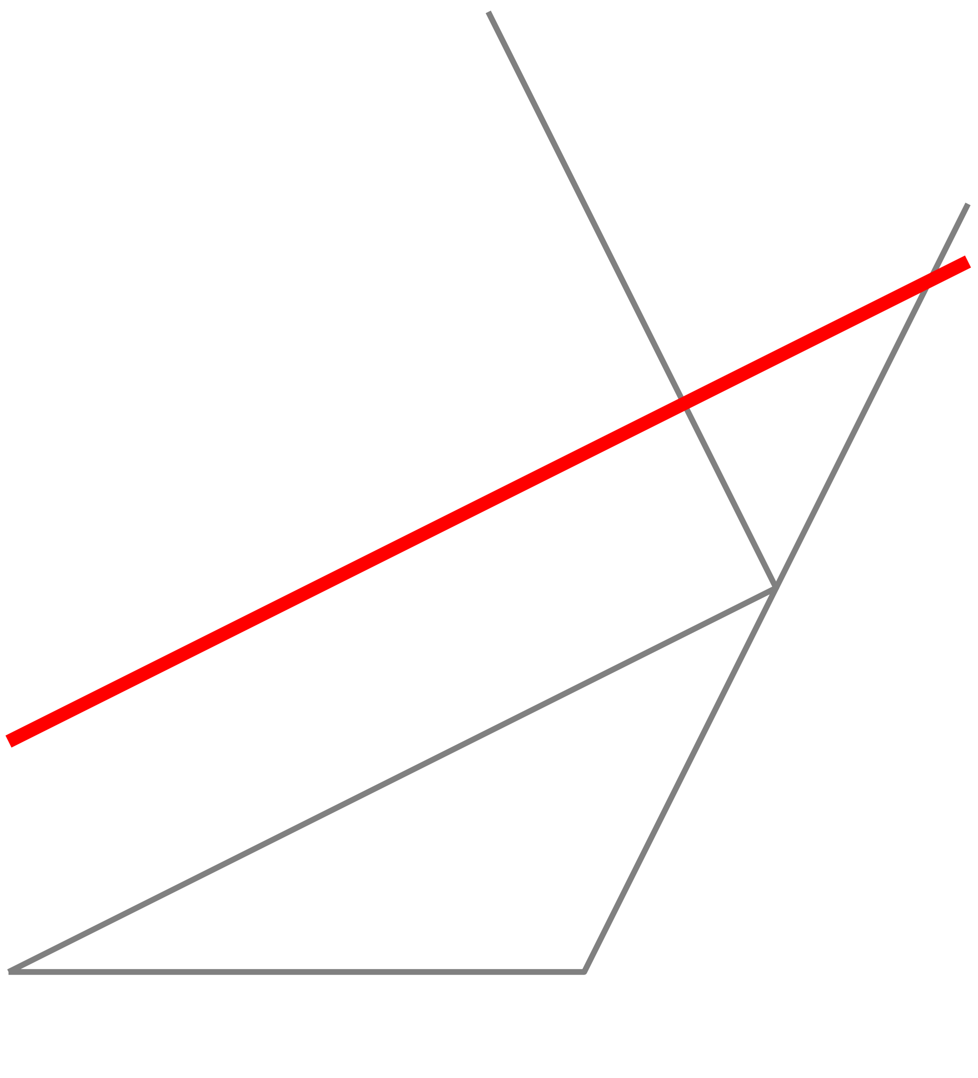

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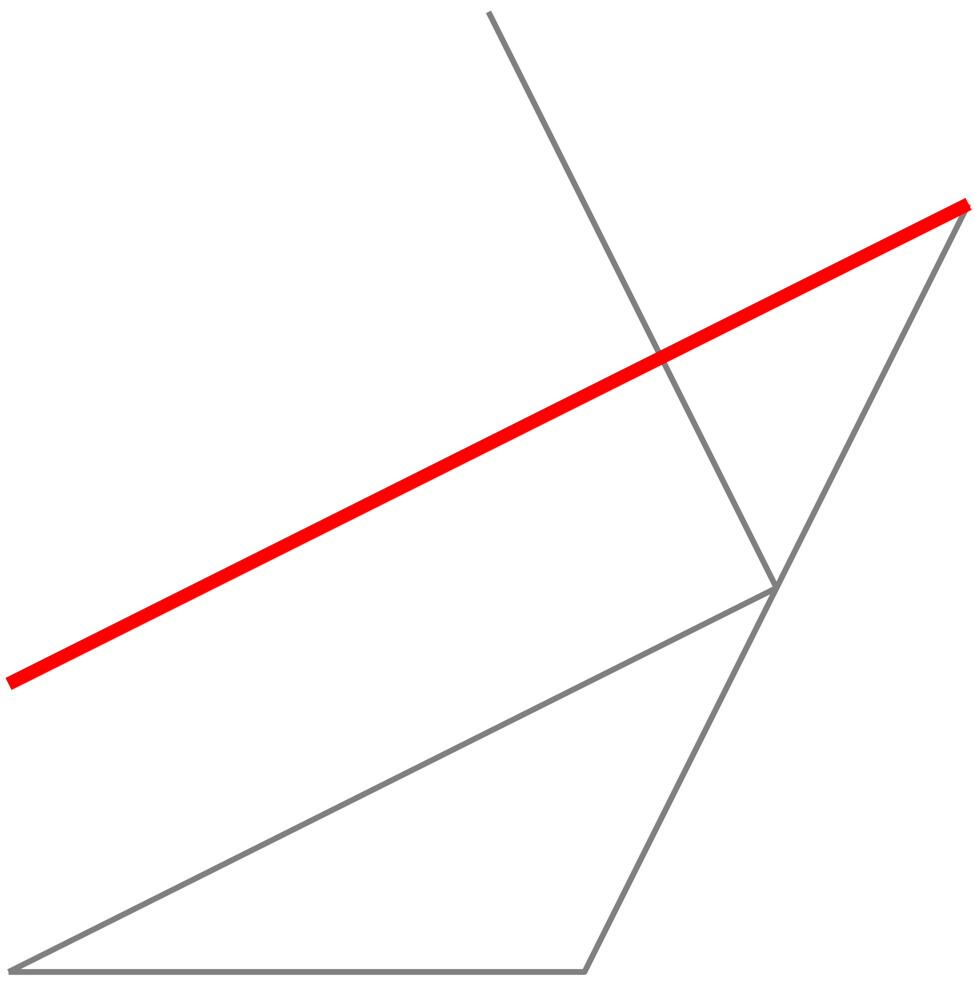
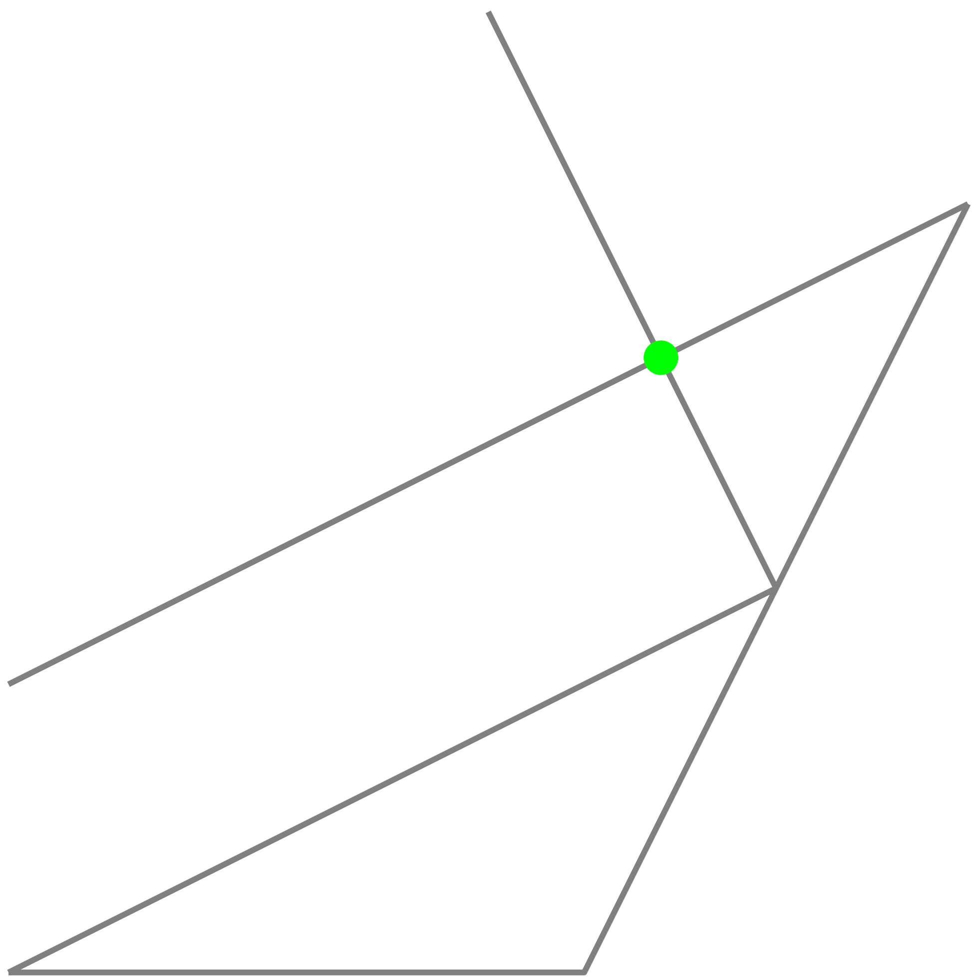
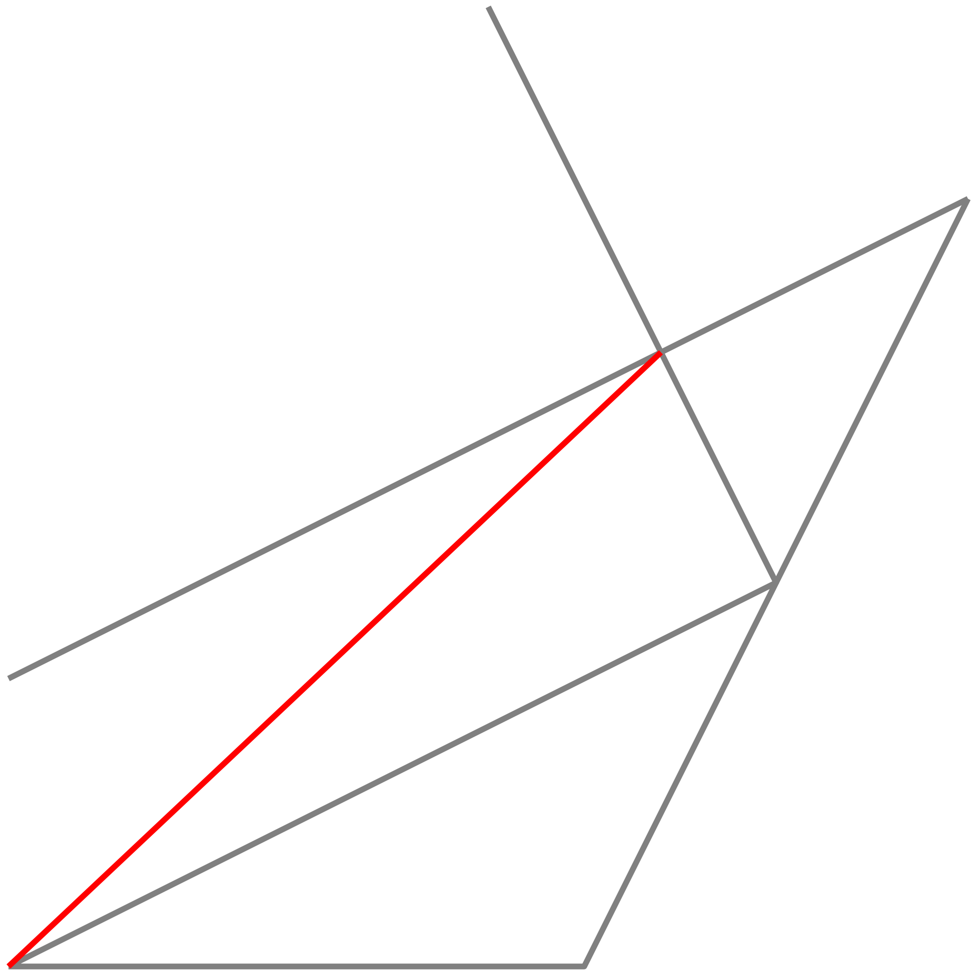


...you can find the point of intersection in the new line of motion.



By connecting the intersection point to the origin we can find another triangle with the same area.



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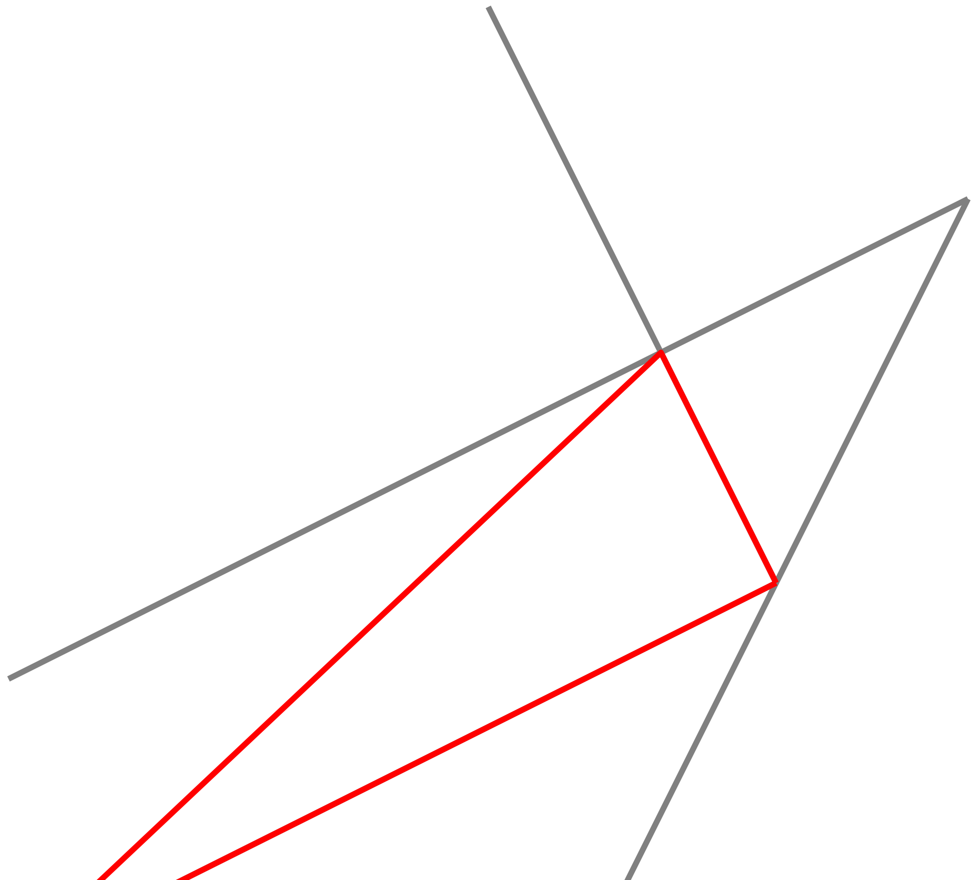
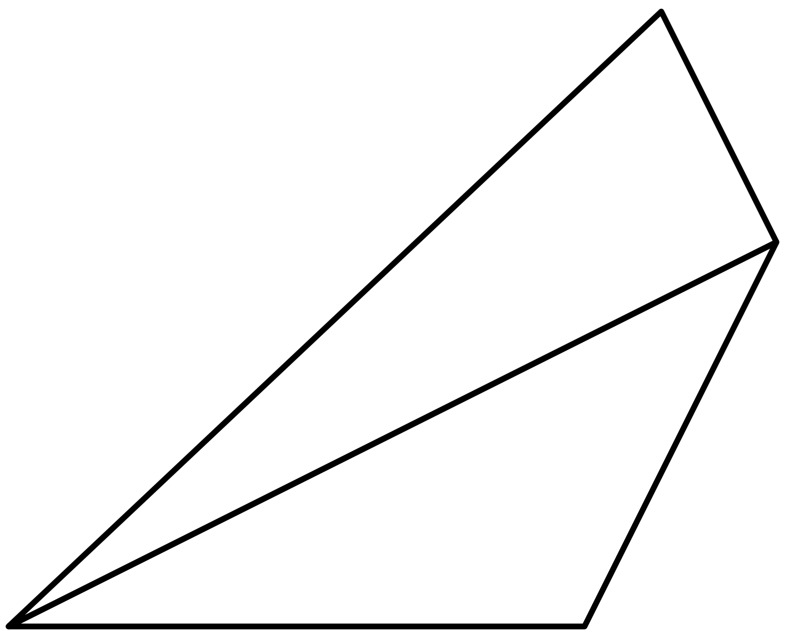
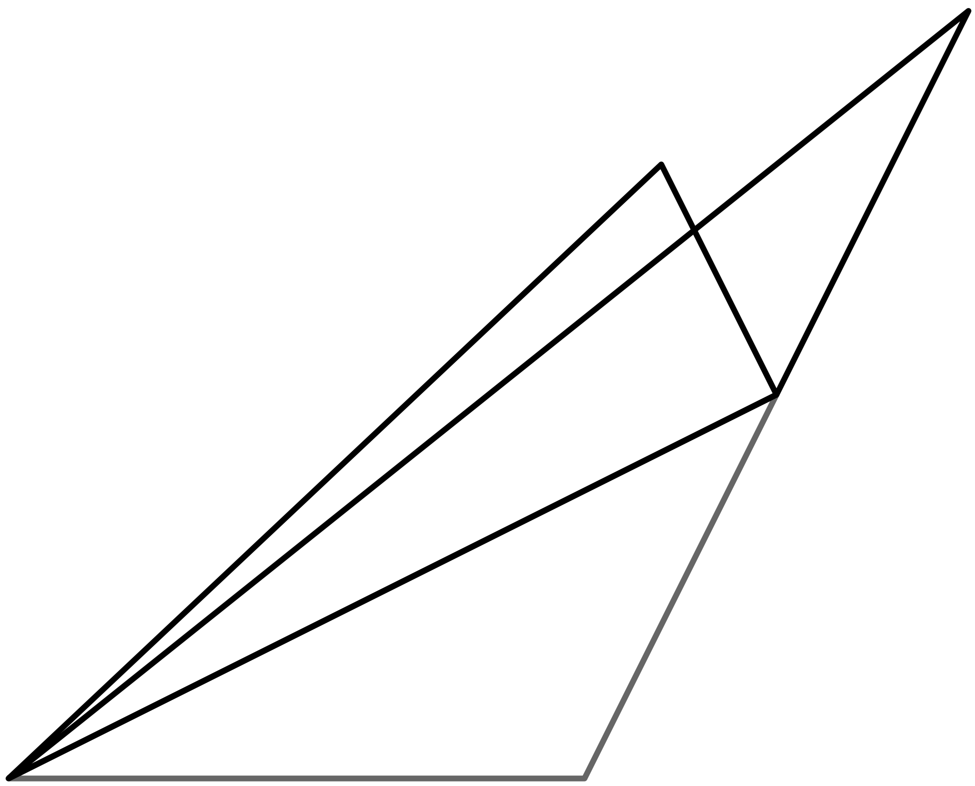
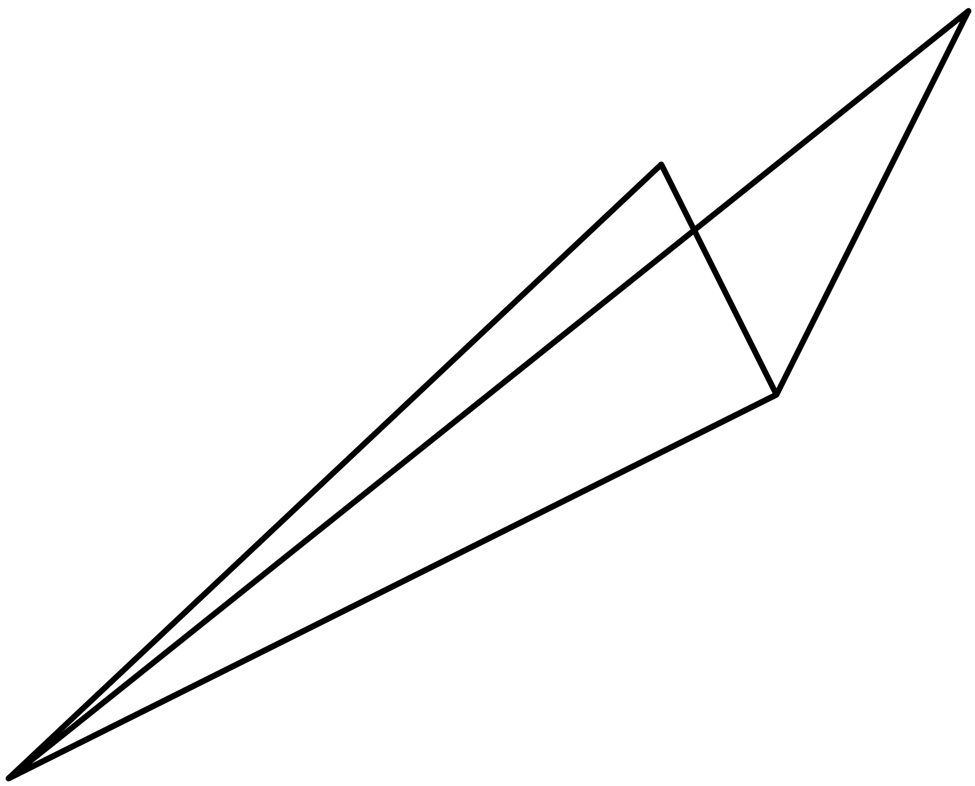
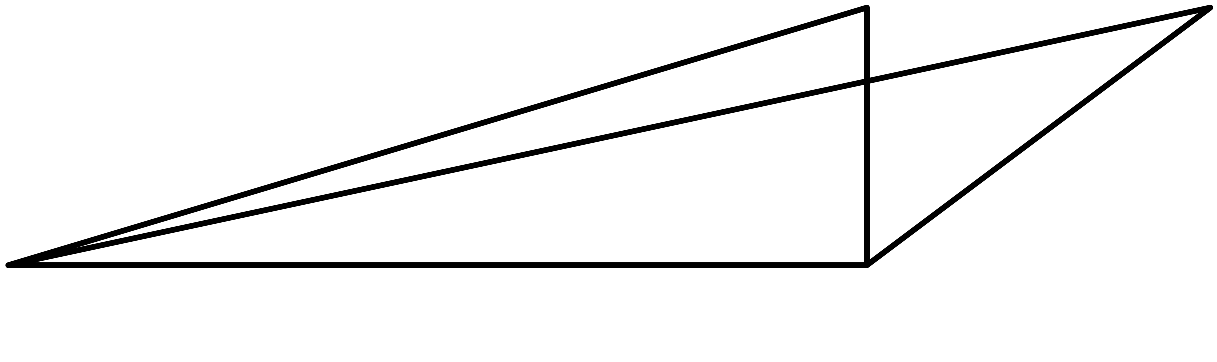


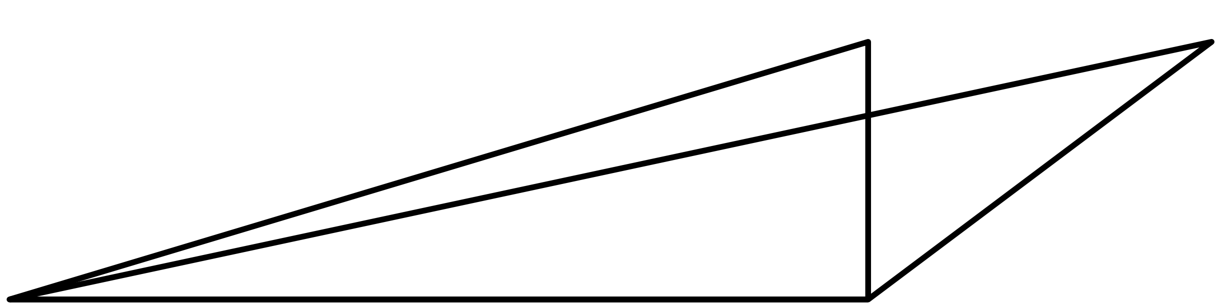




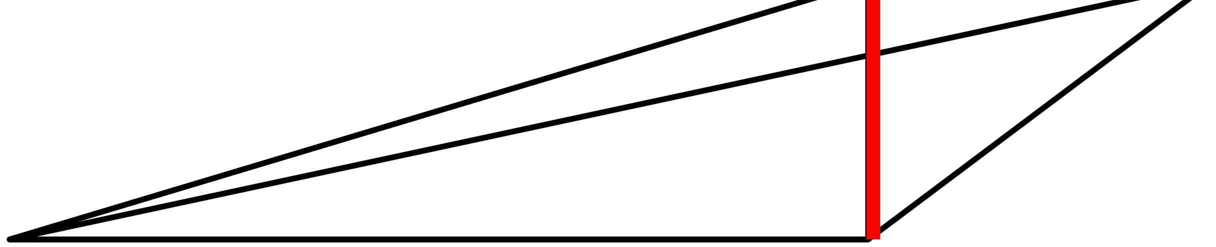
These two triangles have the same area by Euclid I.38.







Like before the two triangles have the same height and base.



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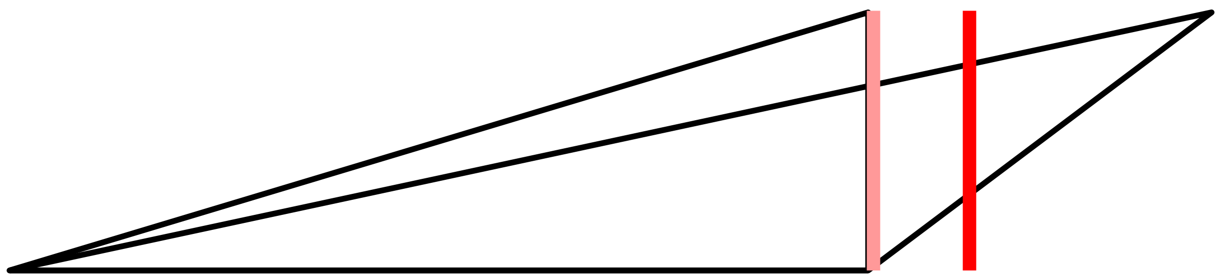

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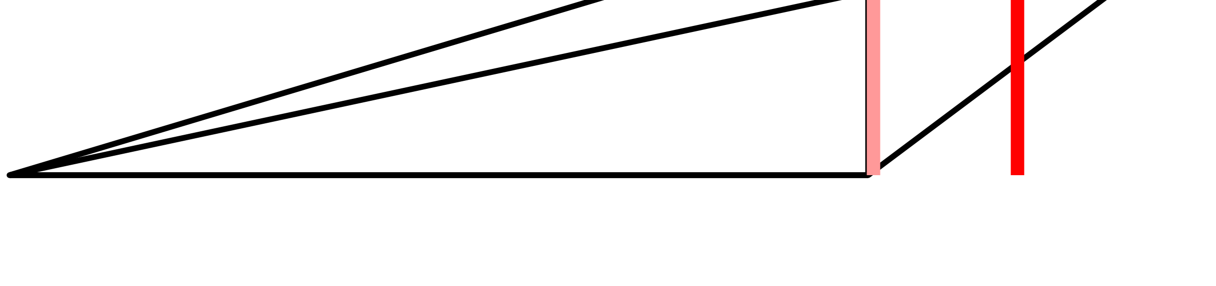
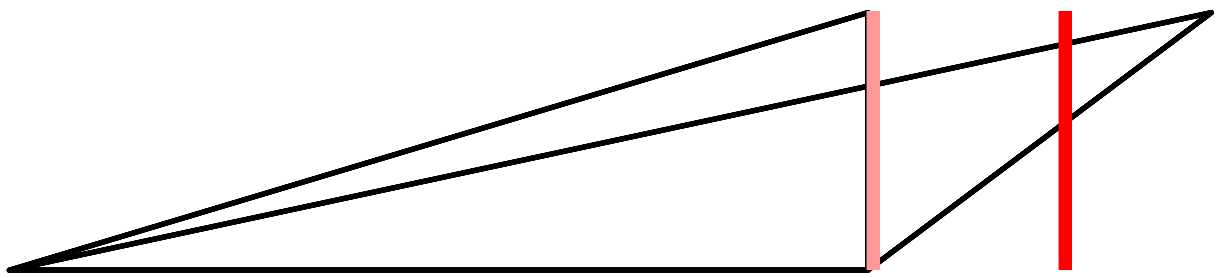
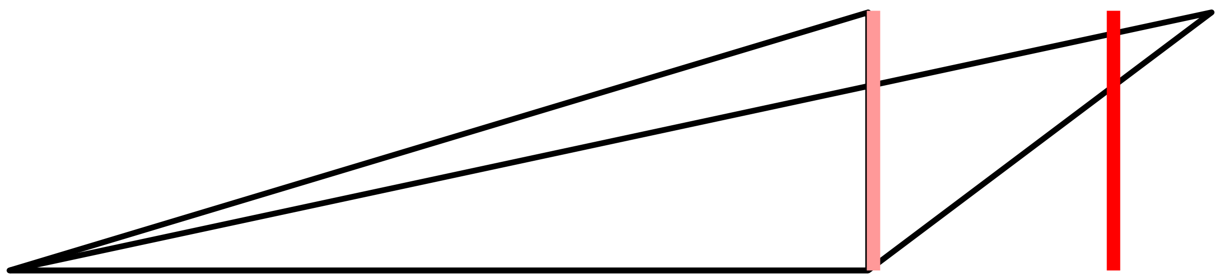


Like before the two triangles have the same height and base.



Like before the two triangles have the same height and base.



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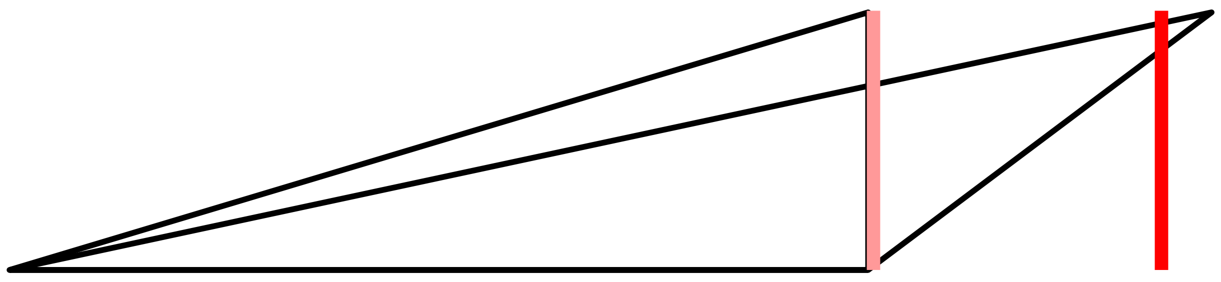
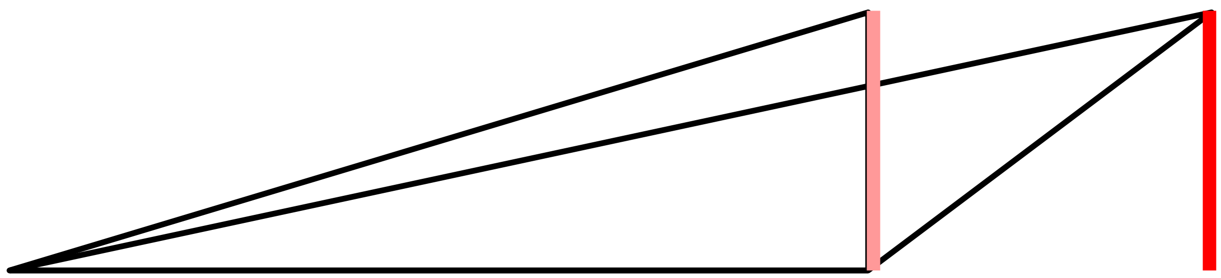
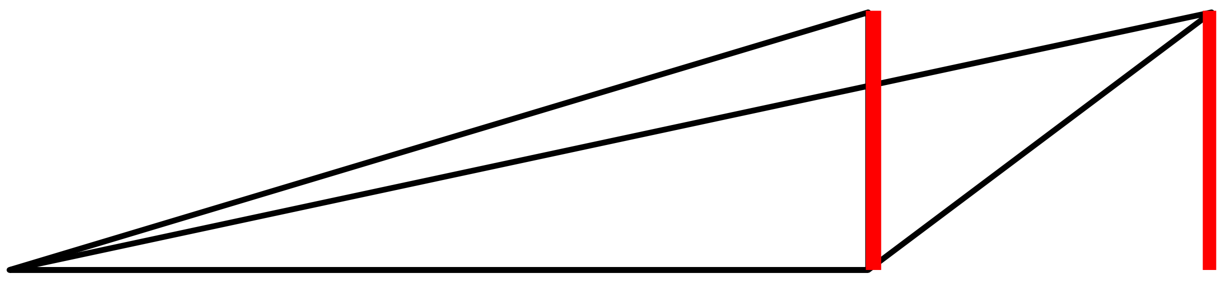


Like before the two triangles have the same height and base.



Like before the two triangles have the same height and base.



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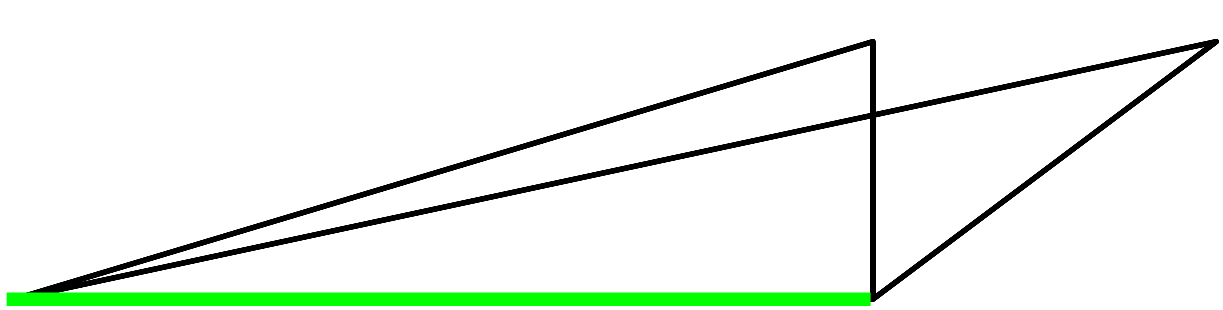

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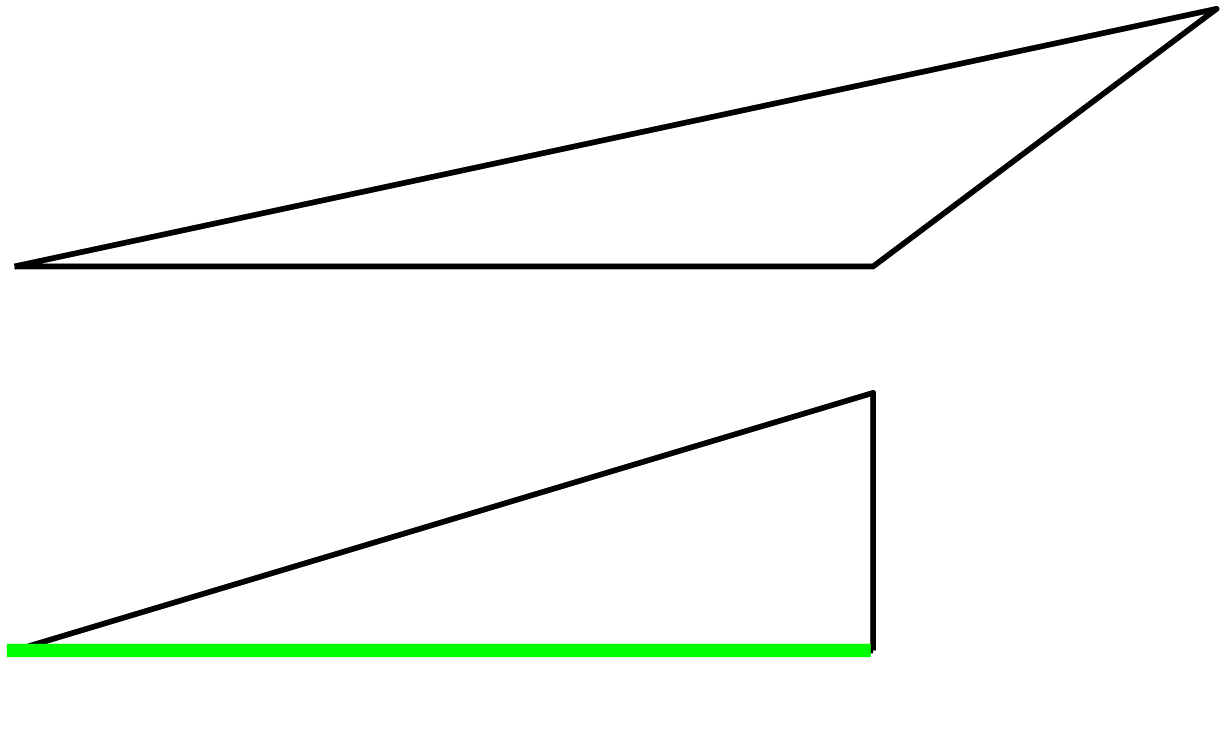

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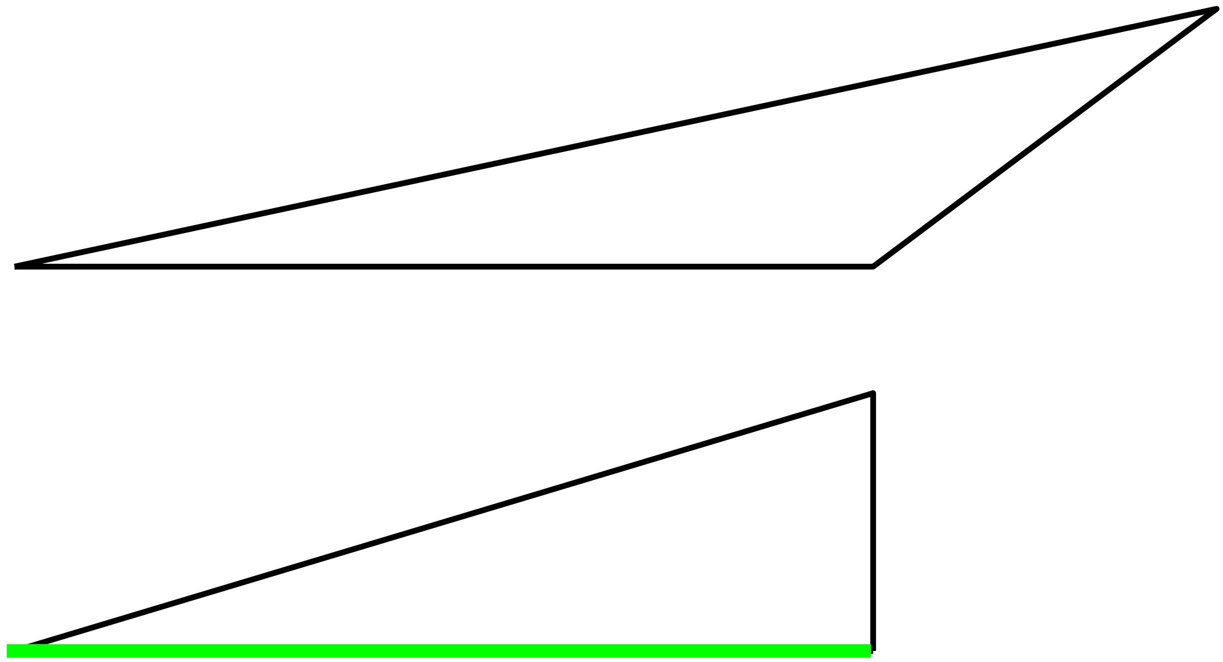

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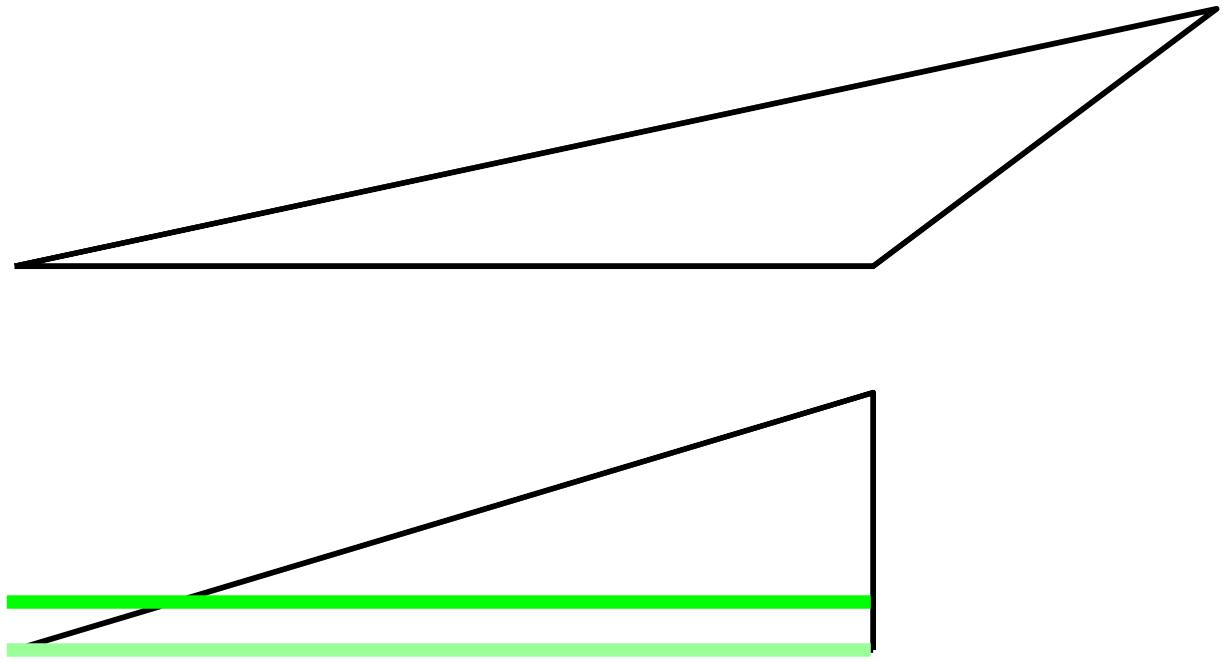

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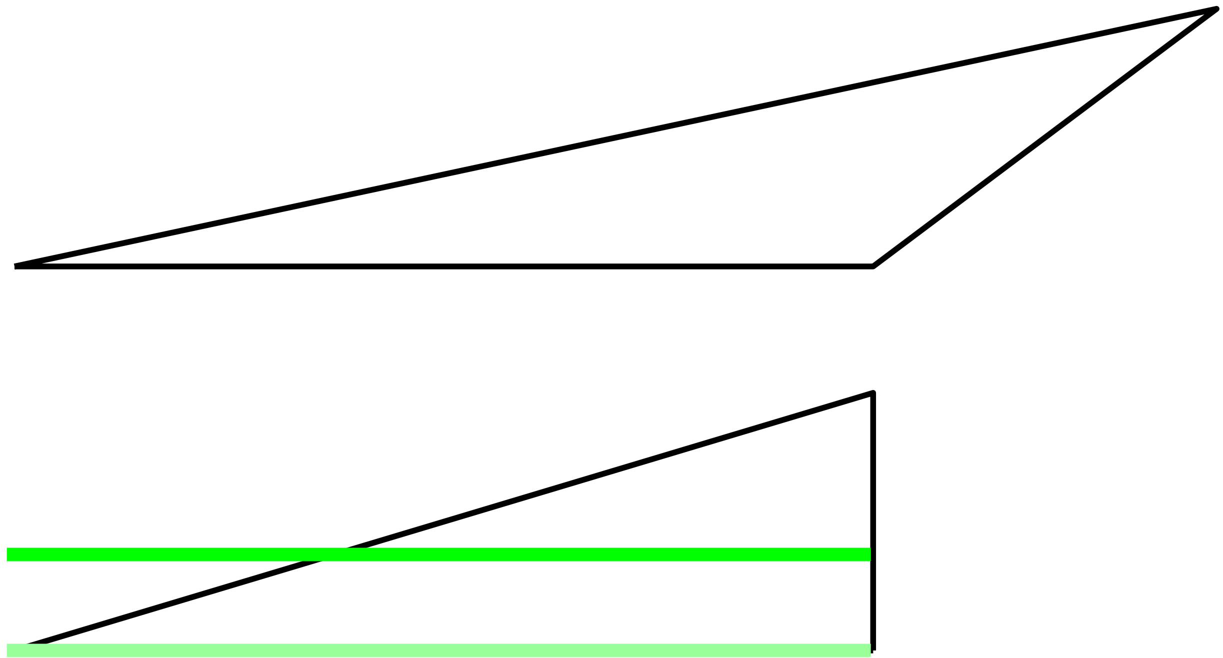

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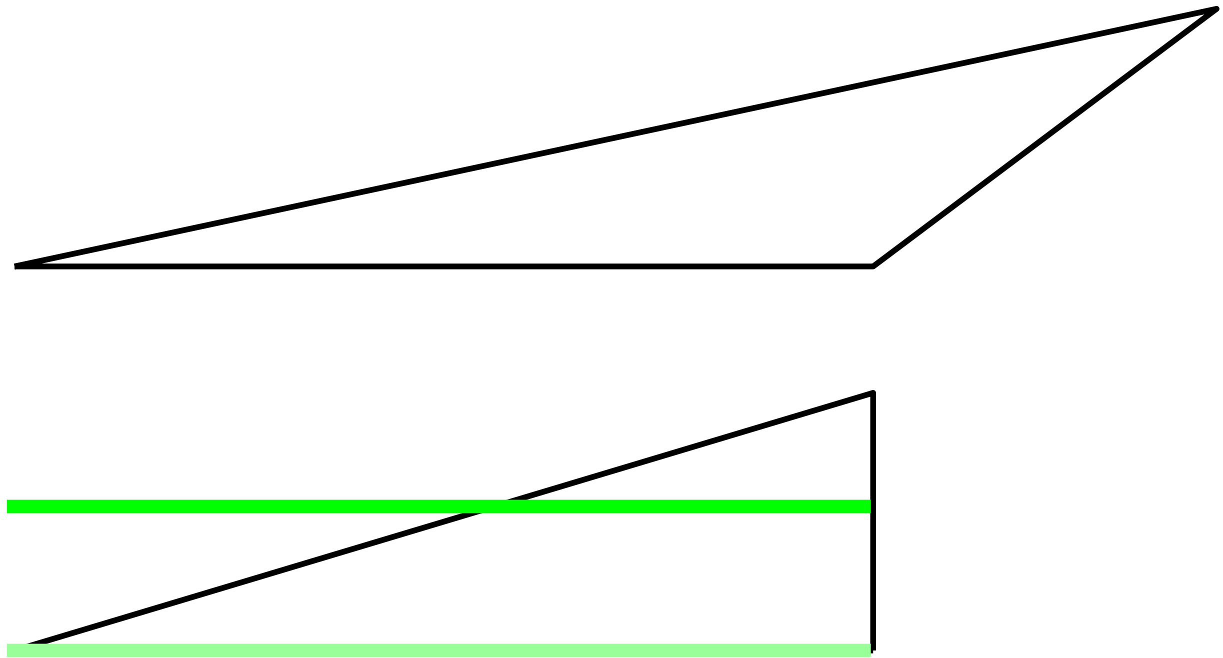

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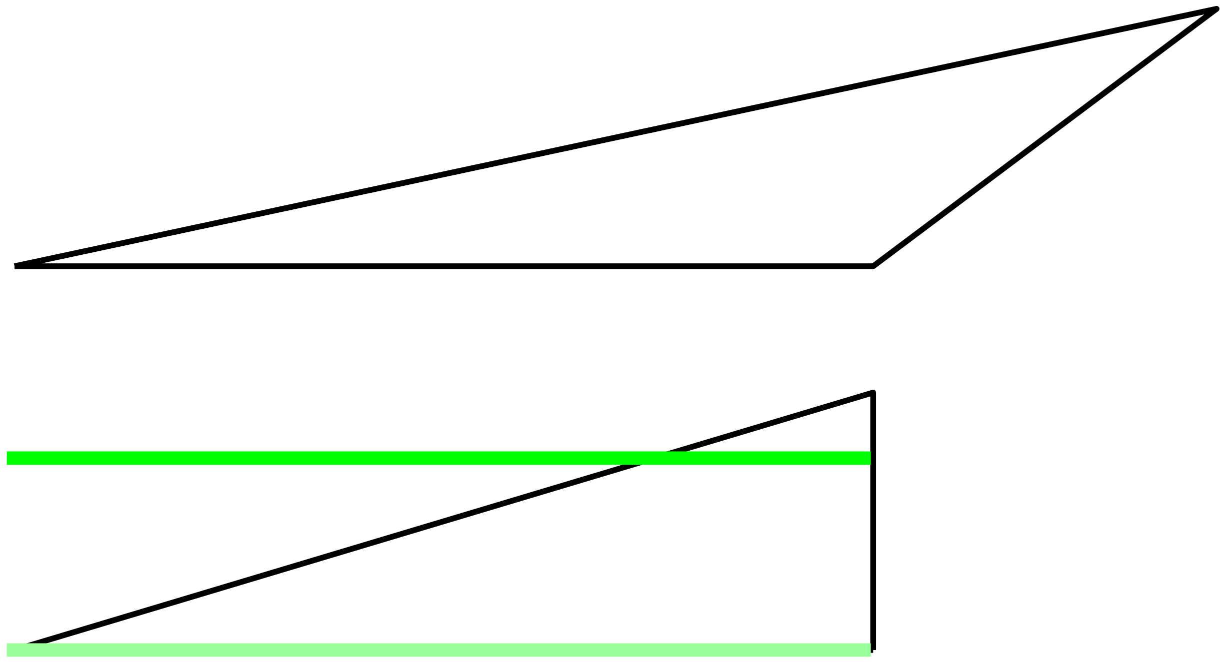

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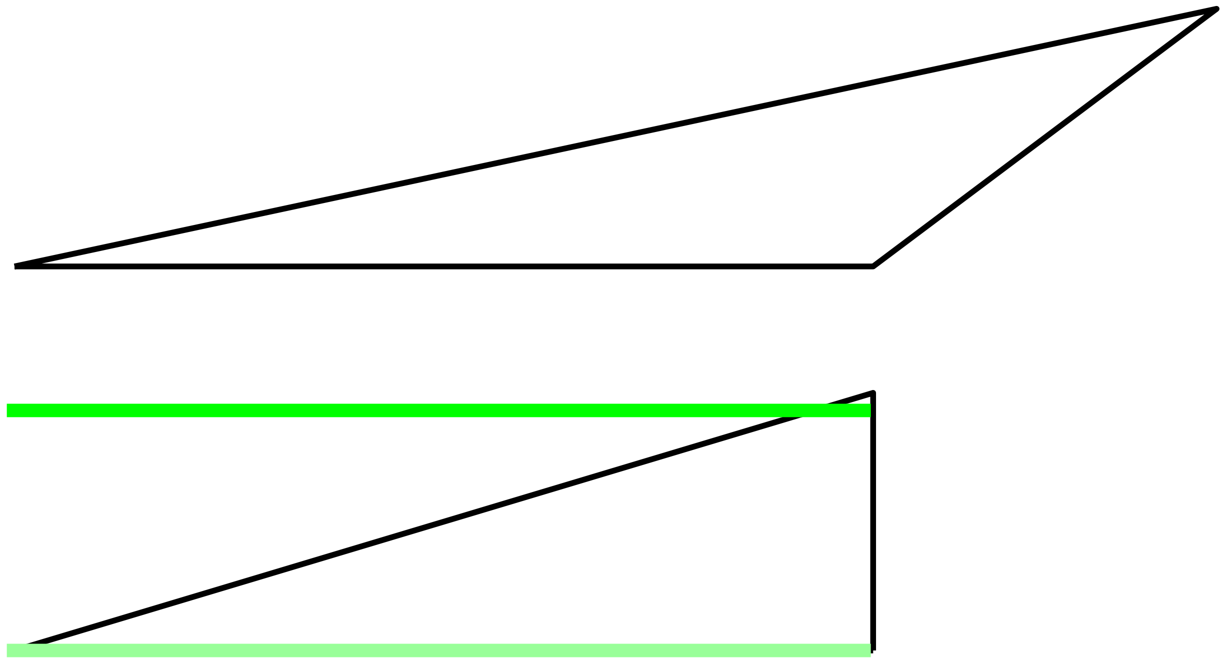

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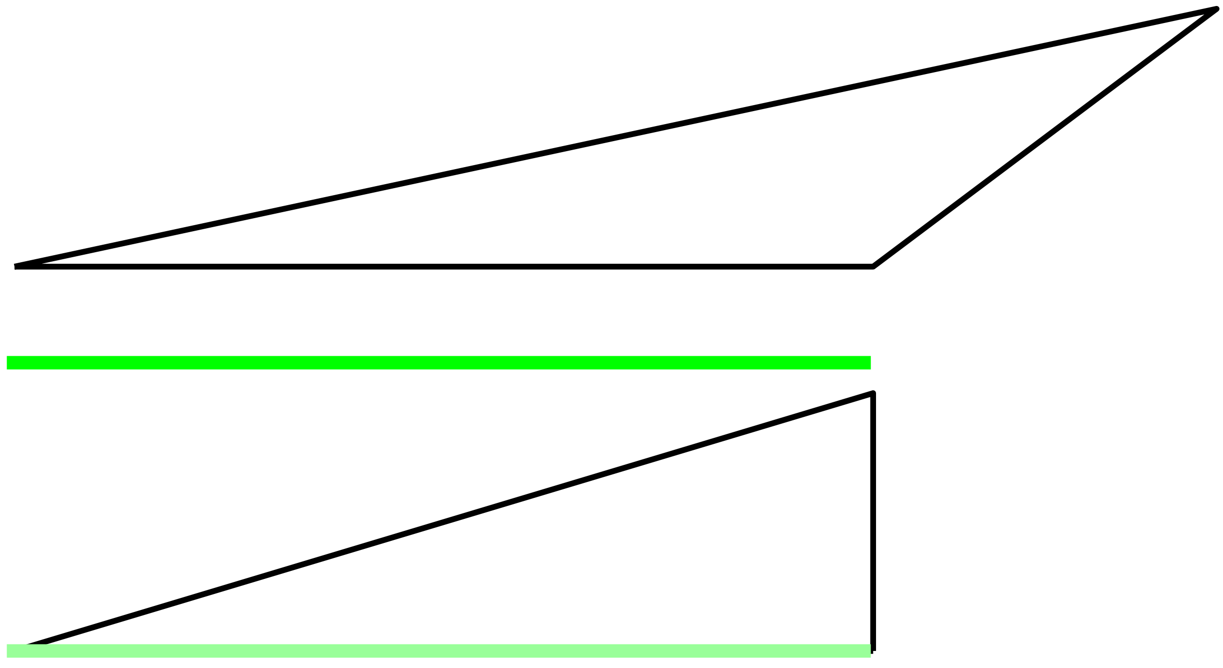

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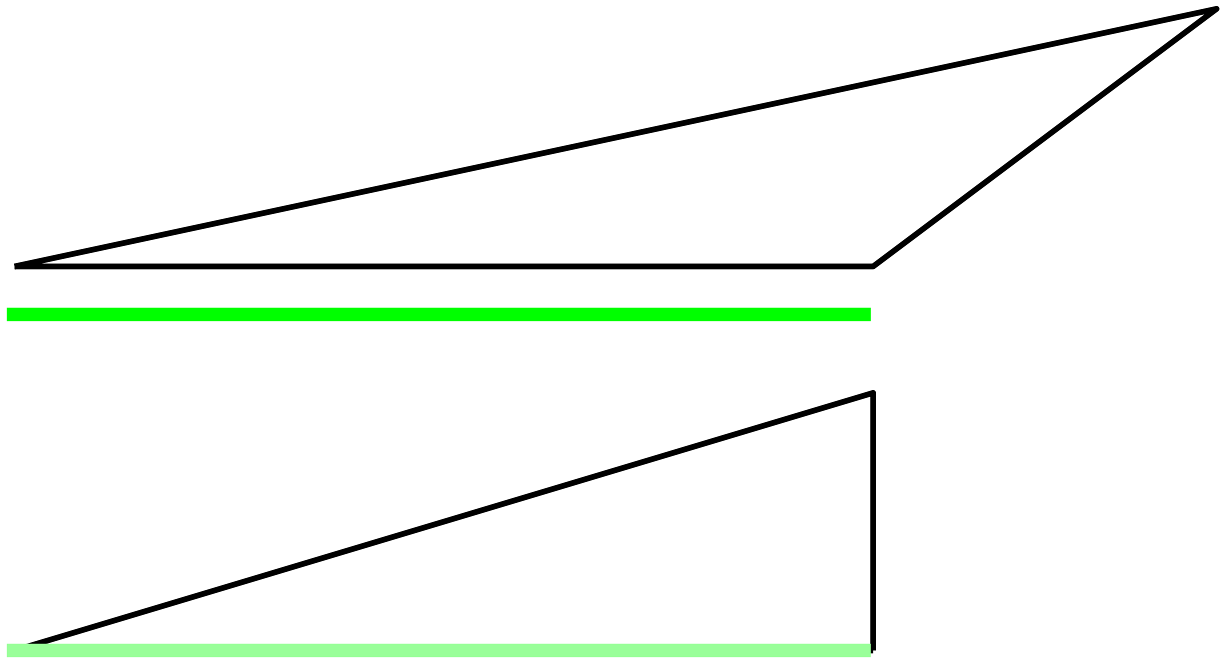

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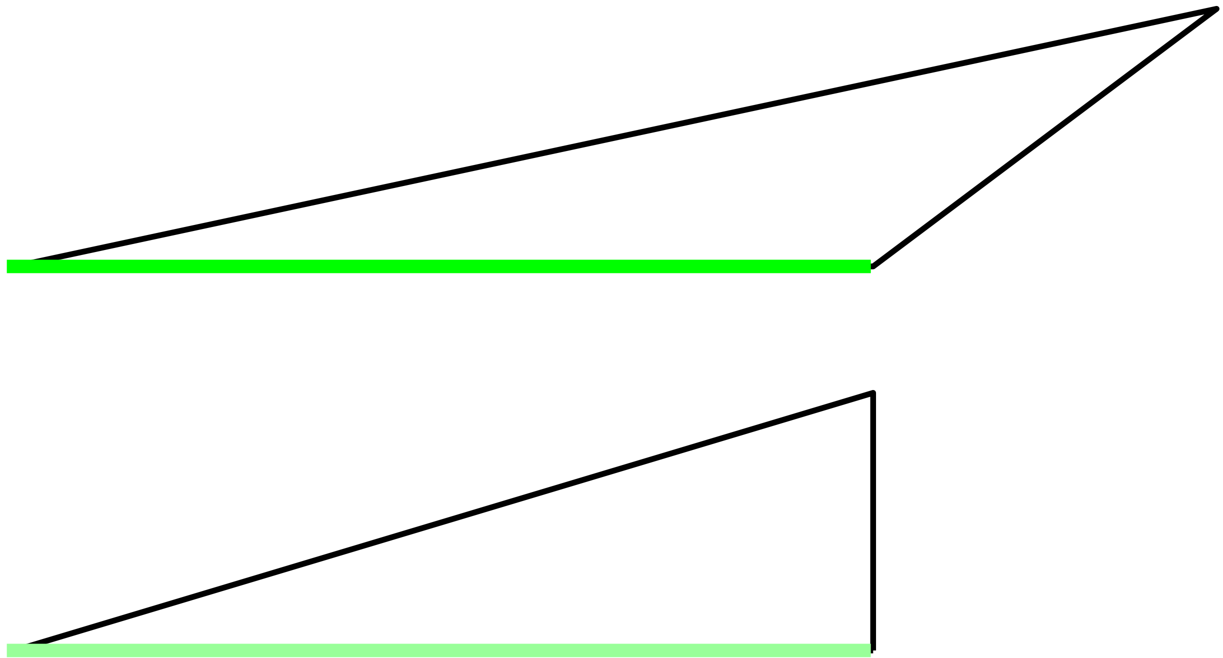

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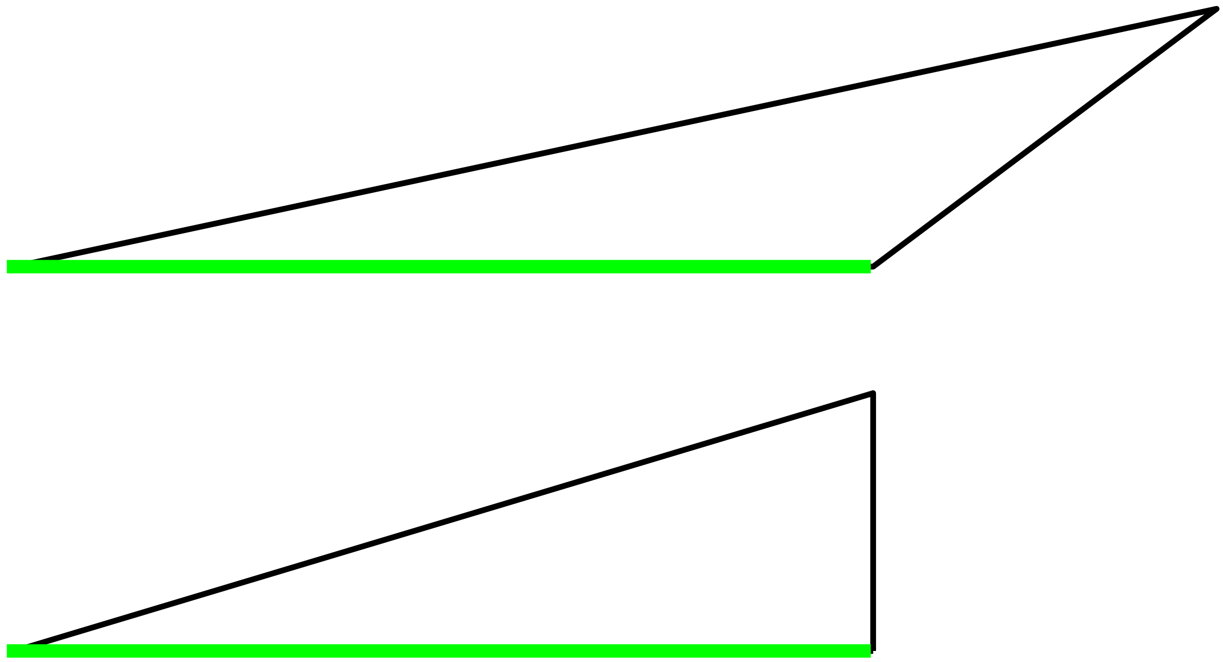
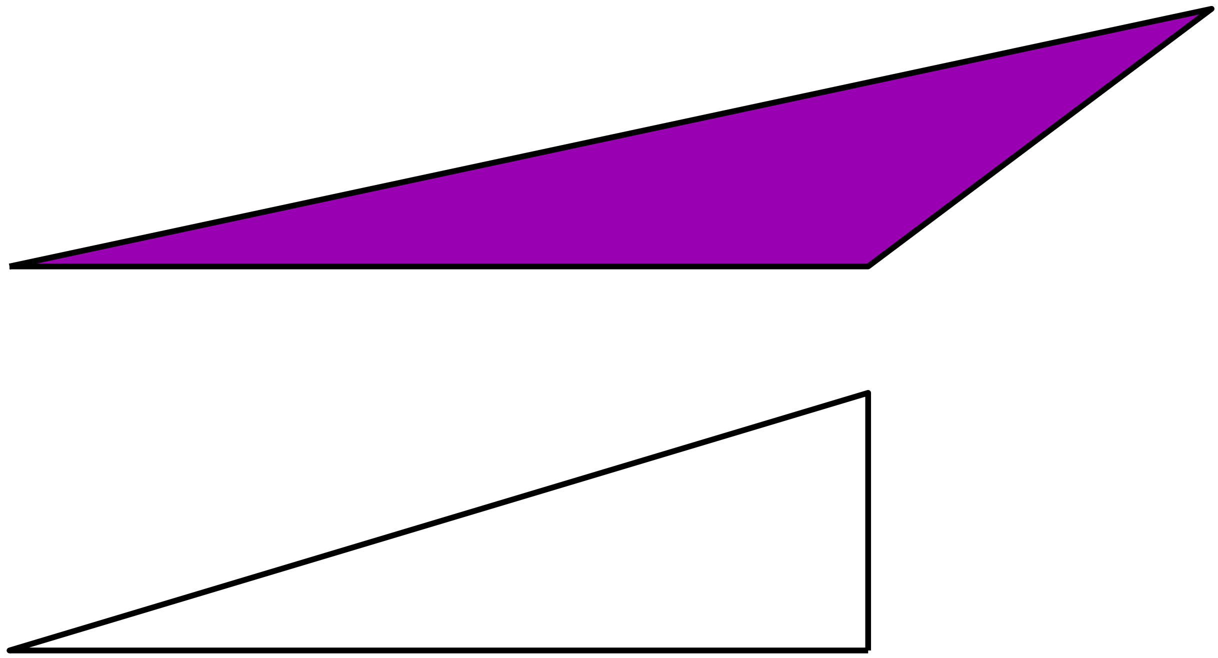
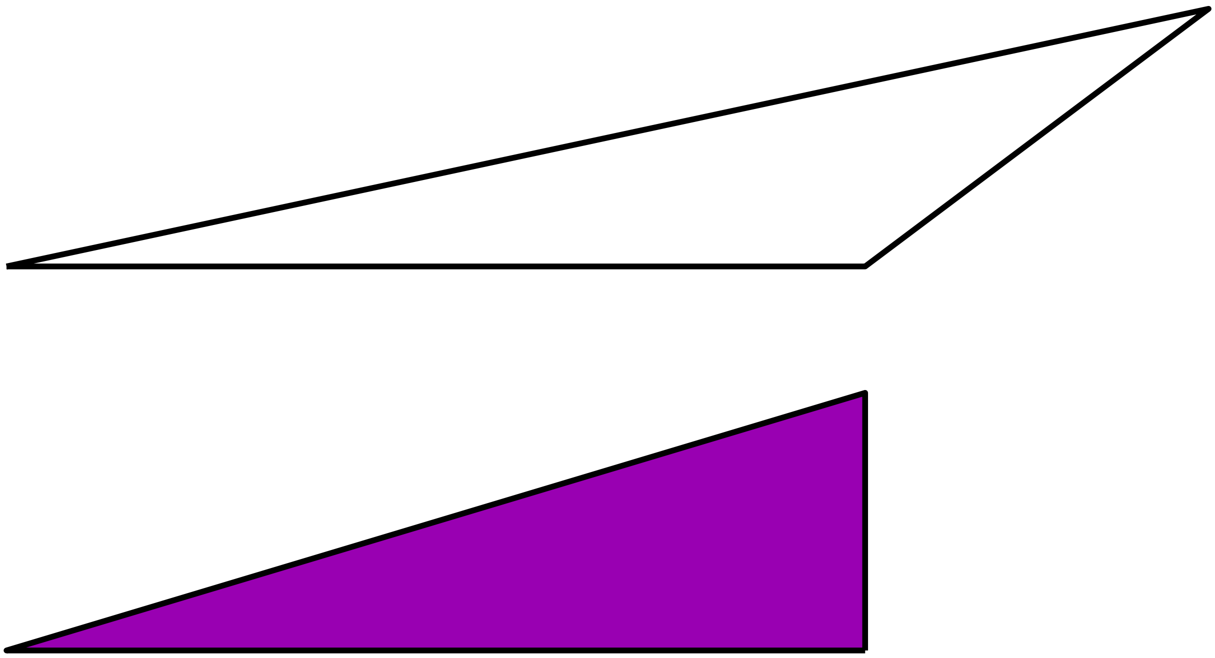


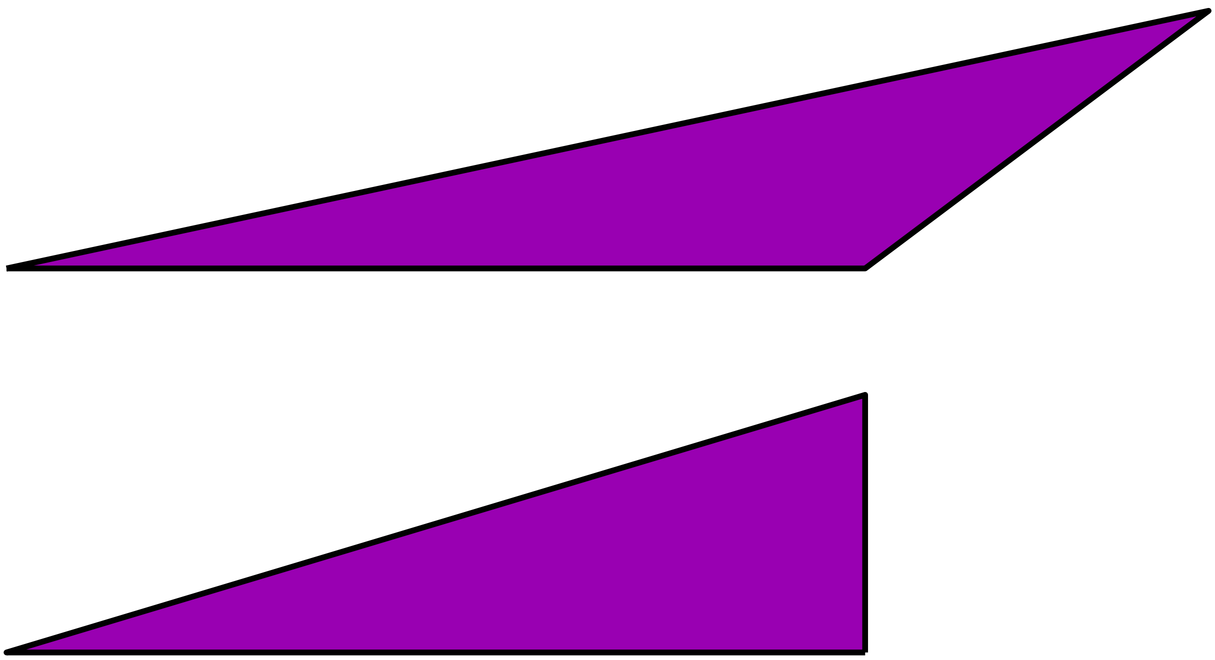
They have the same areas.



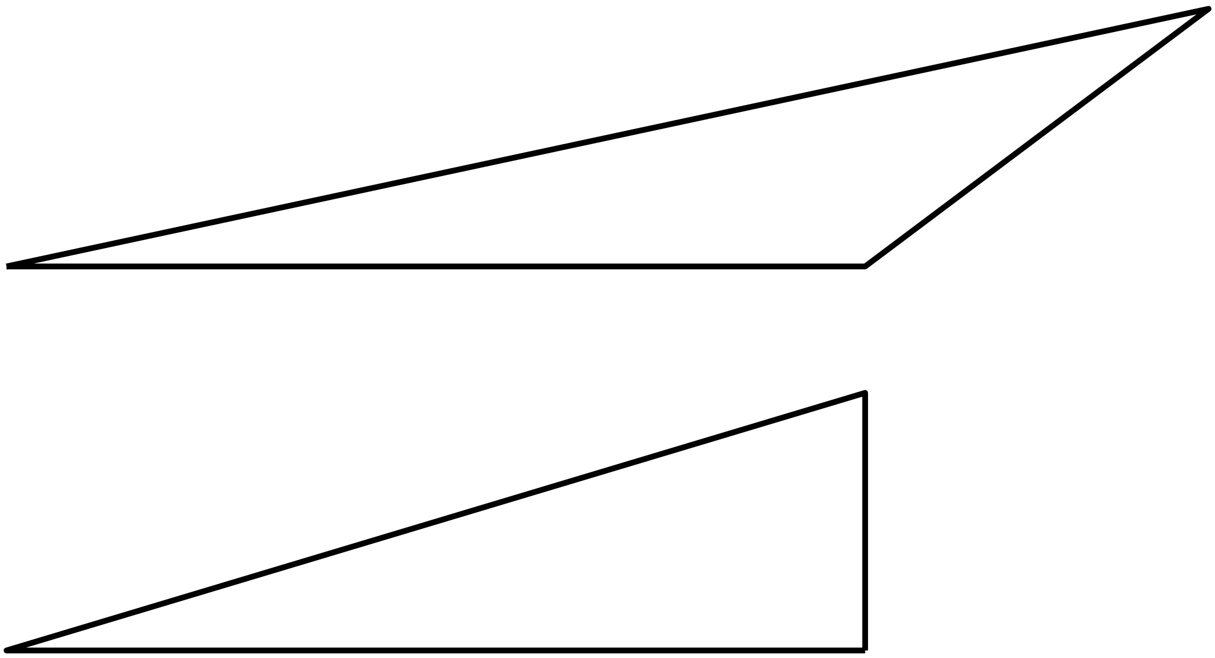
They have the same areas.

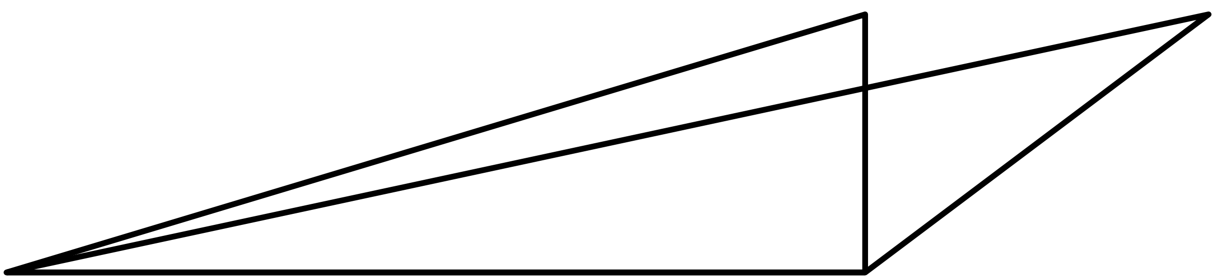


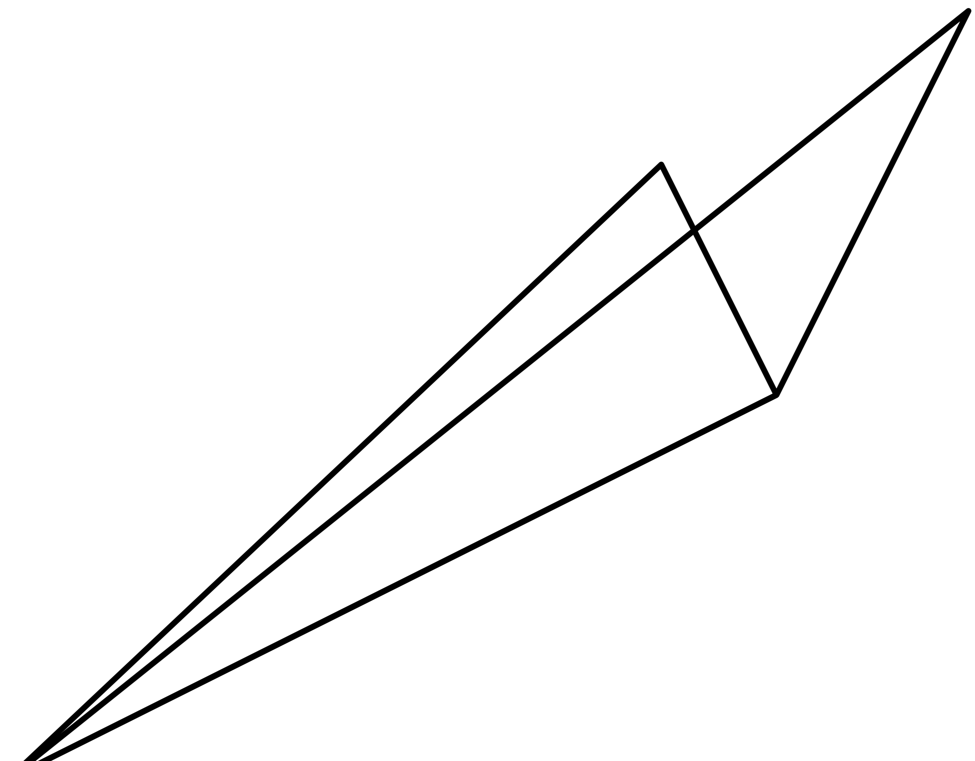
They have the same areas.

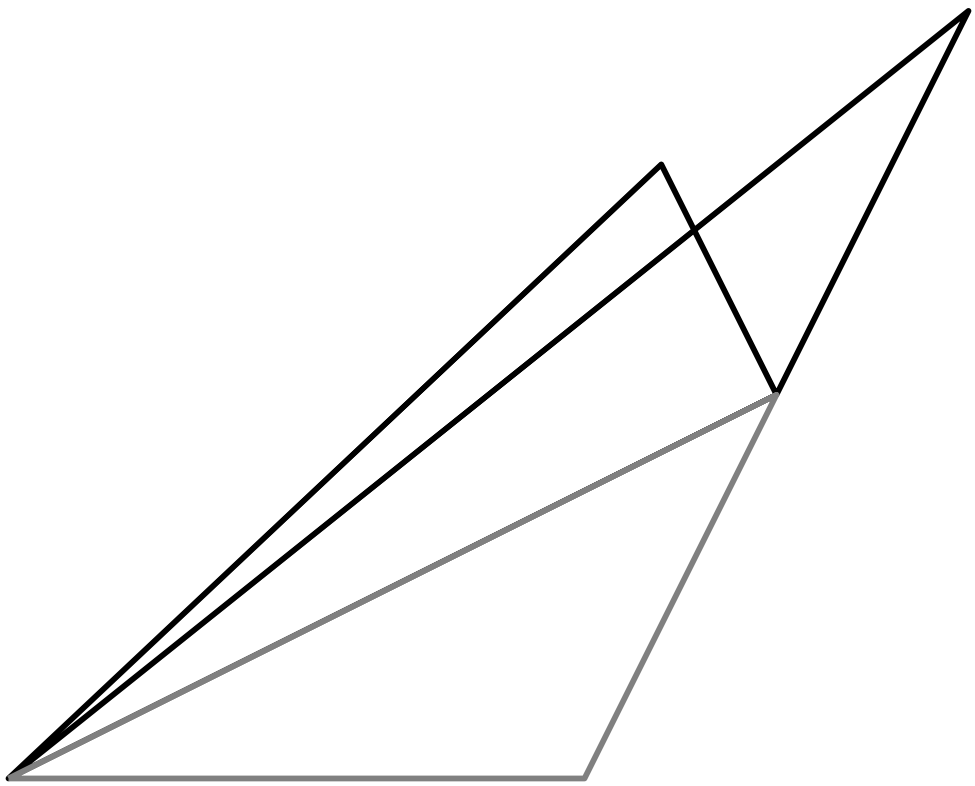


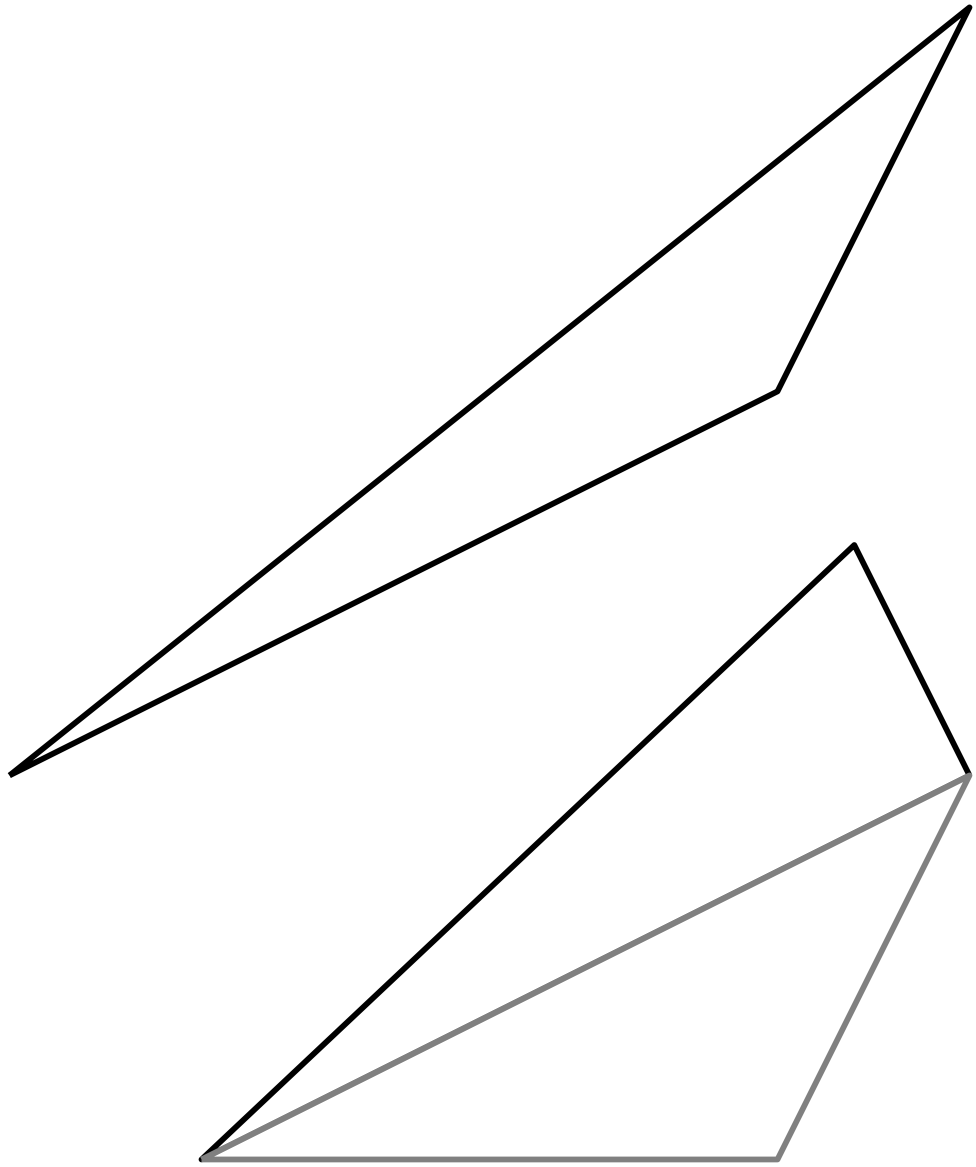
They have the same areas.

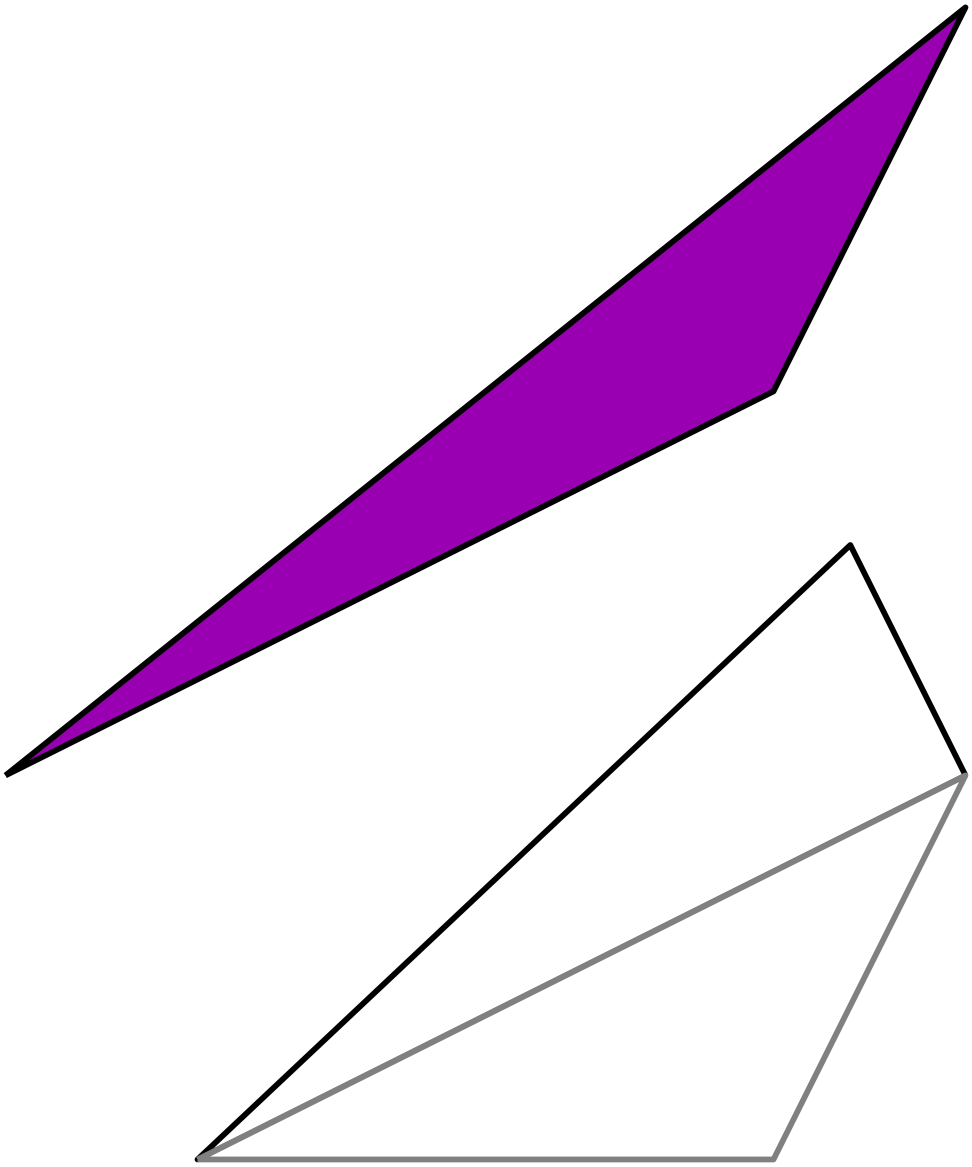


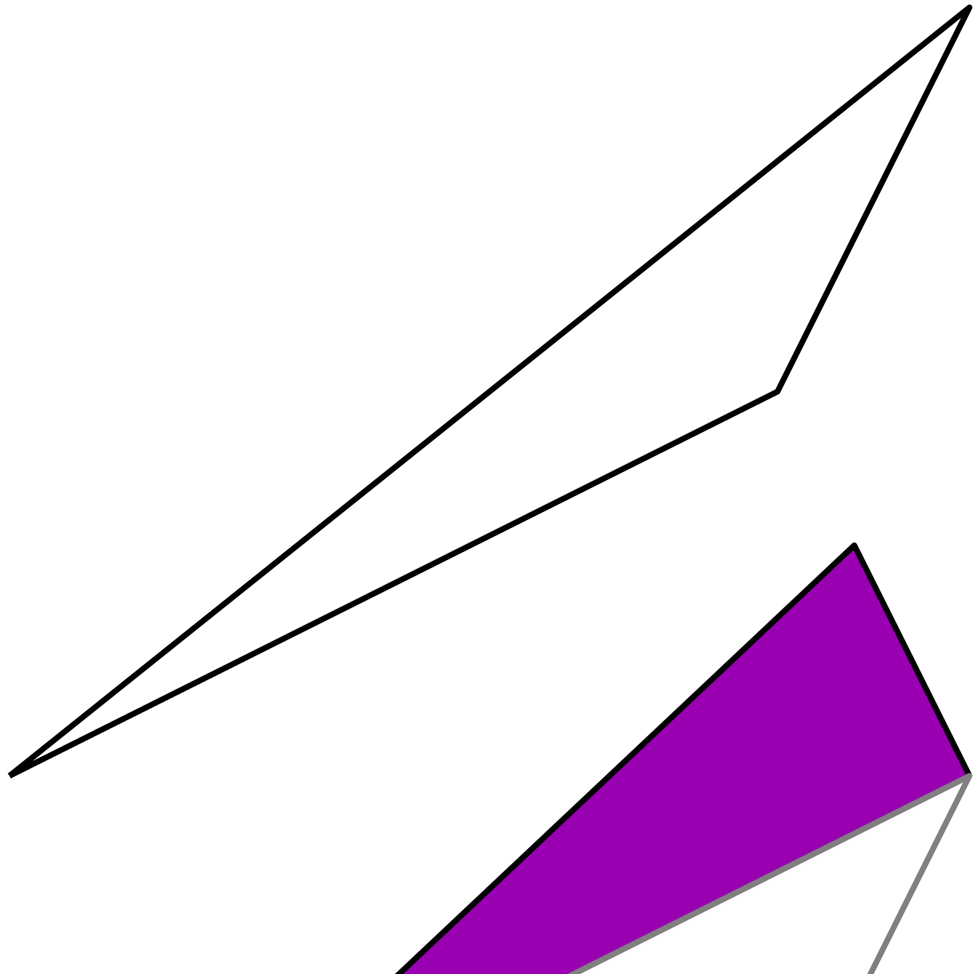


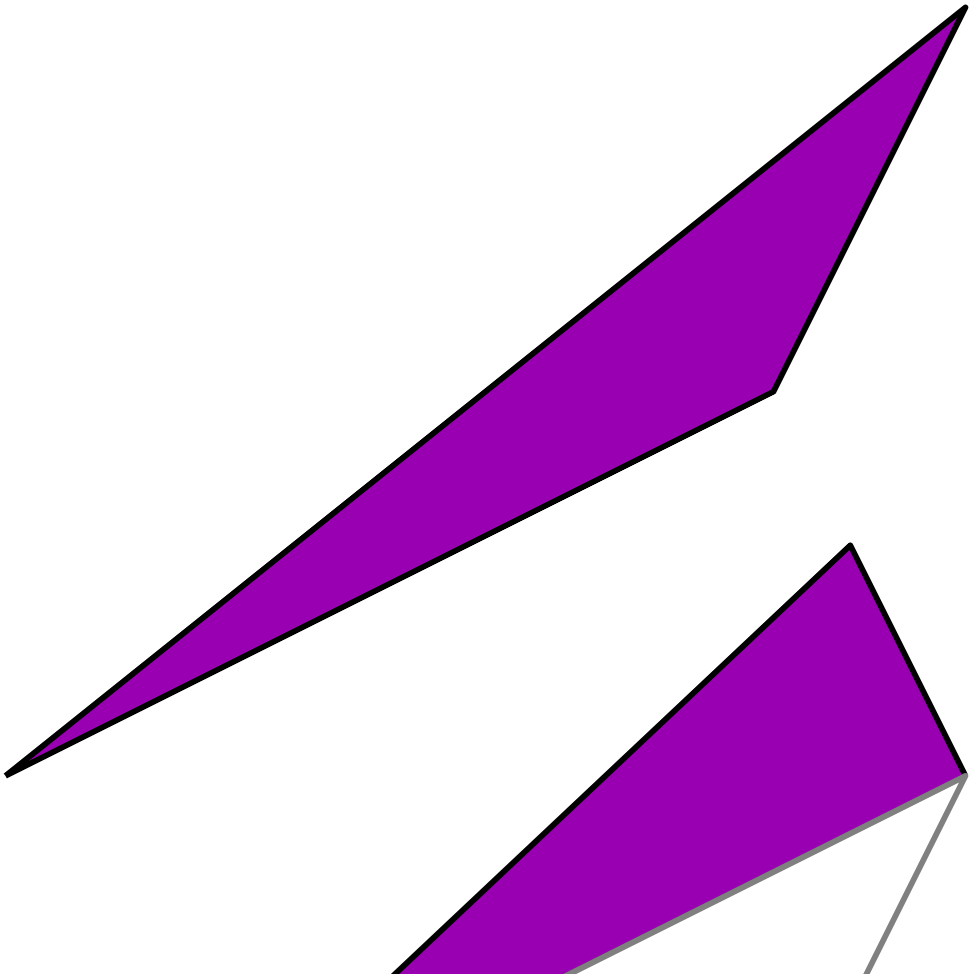


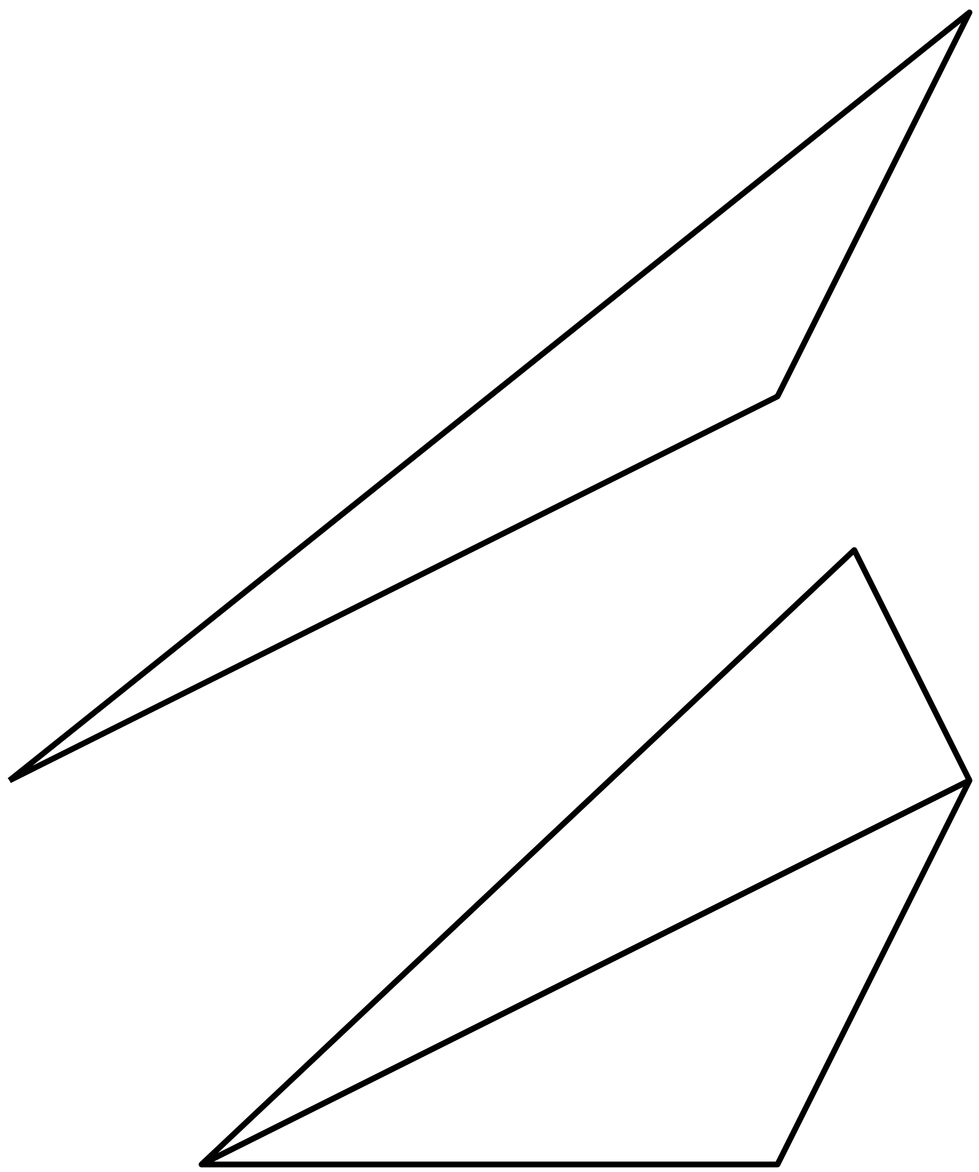


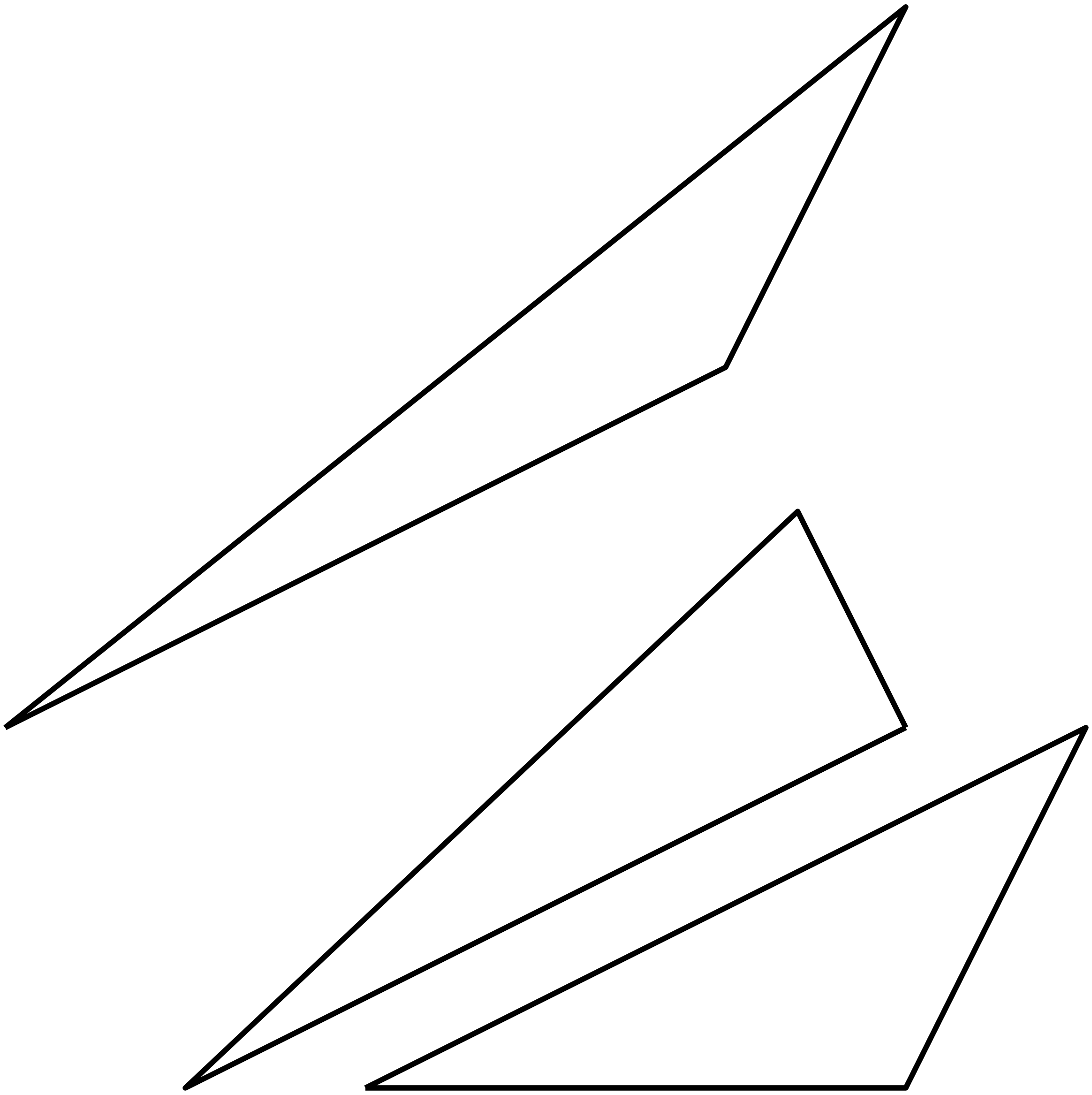




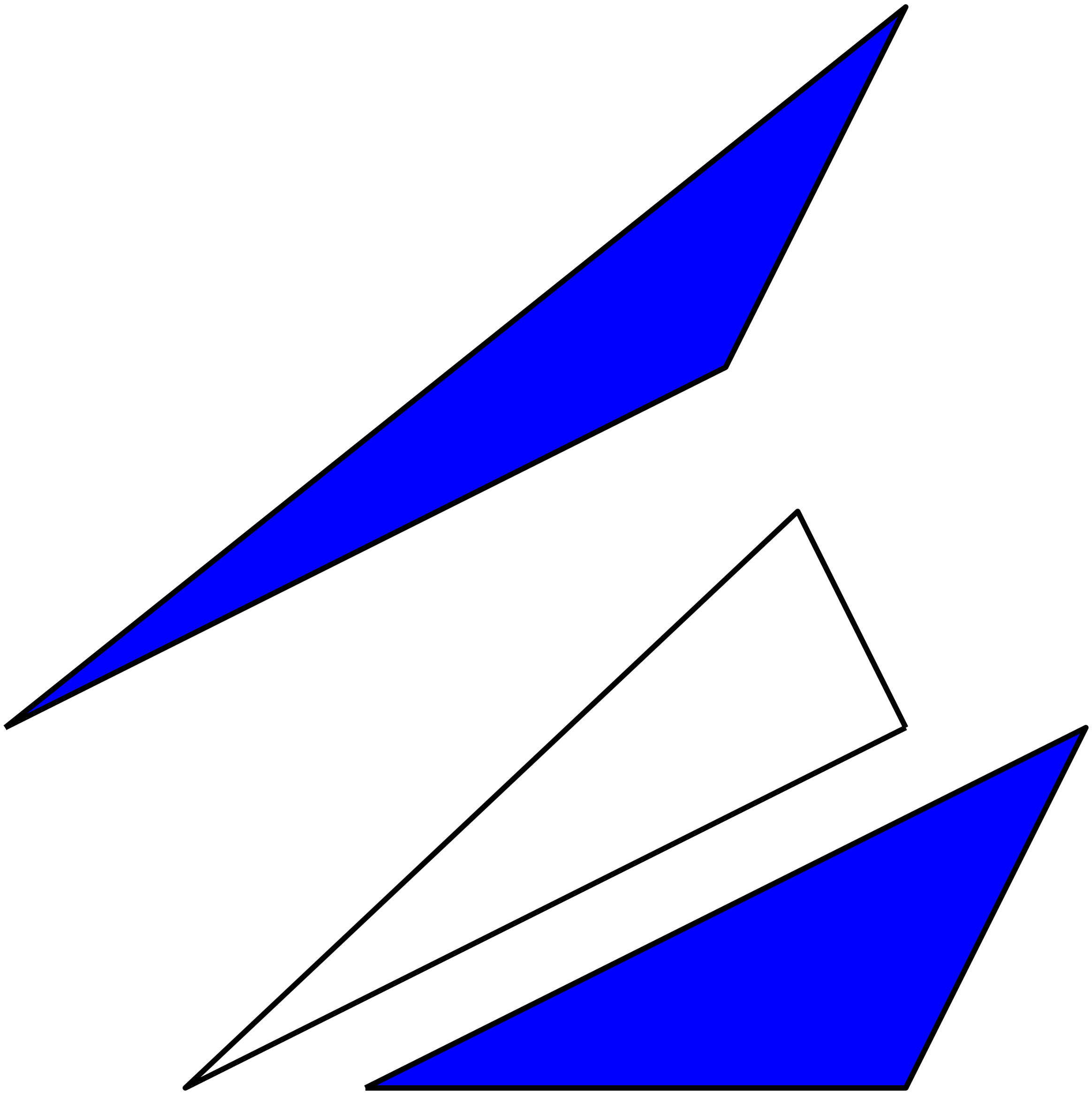


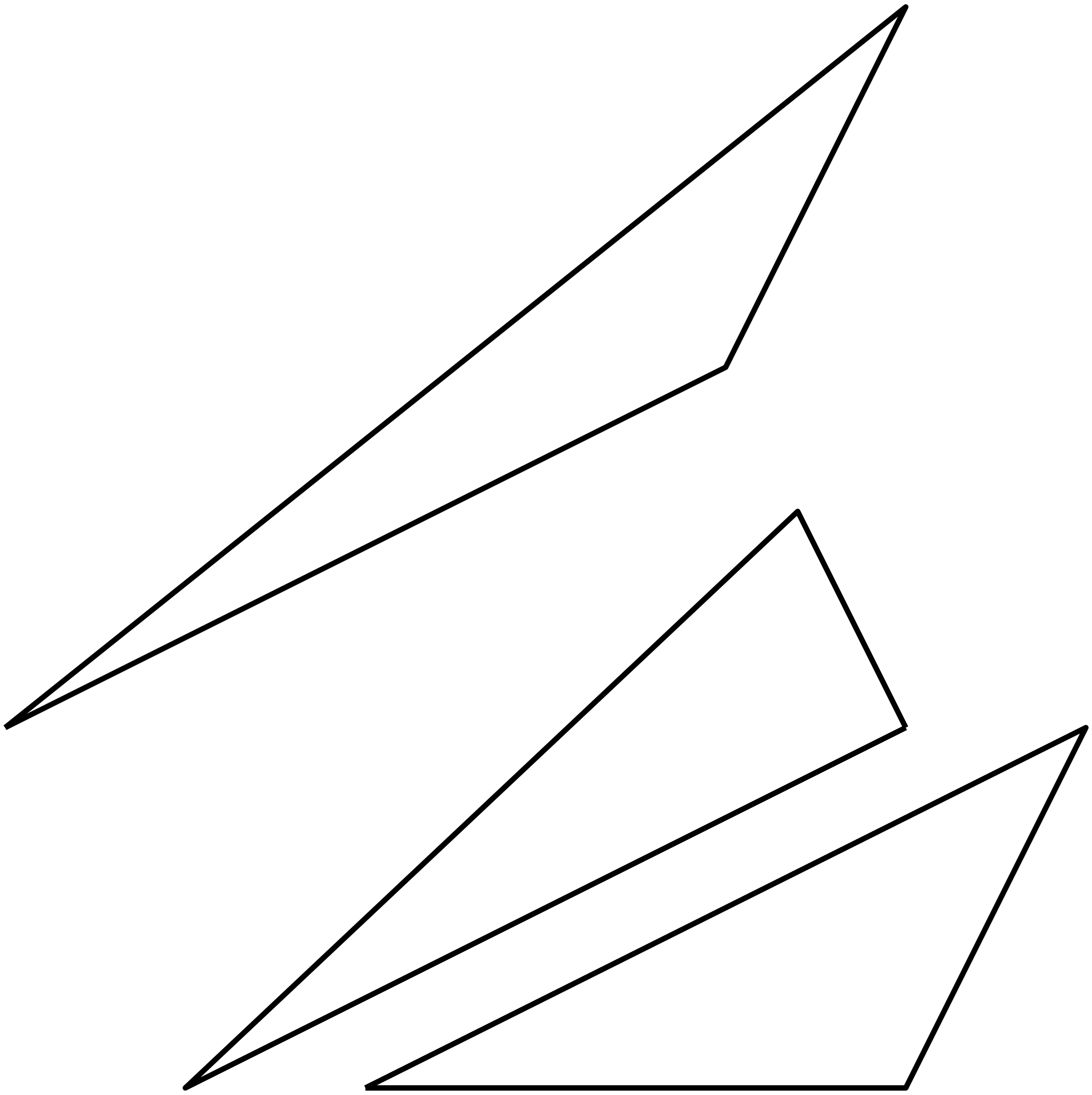




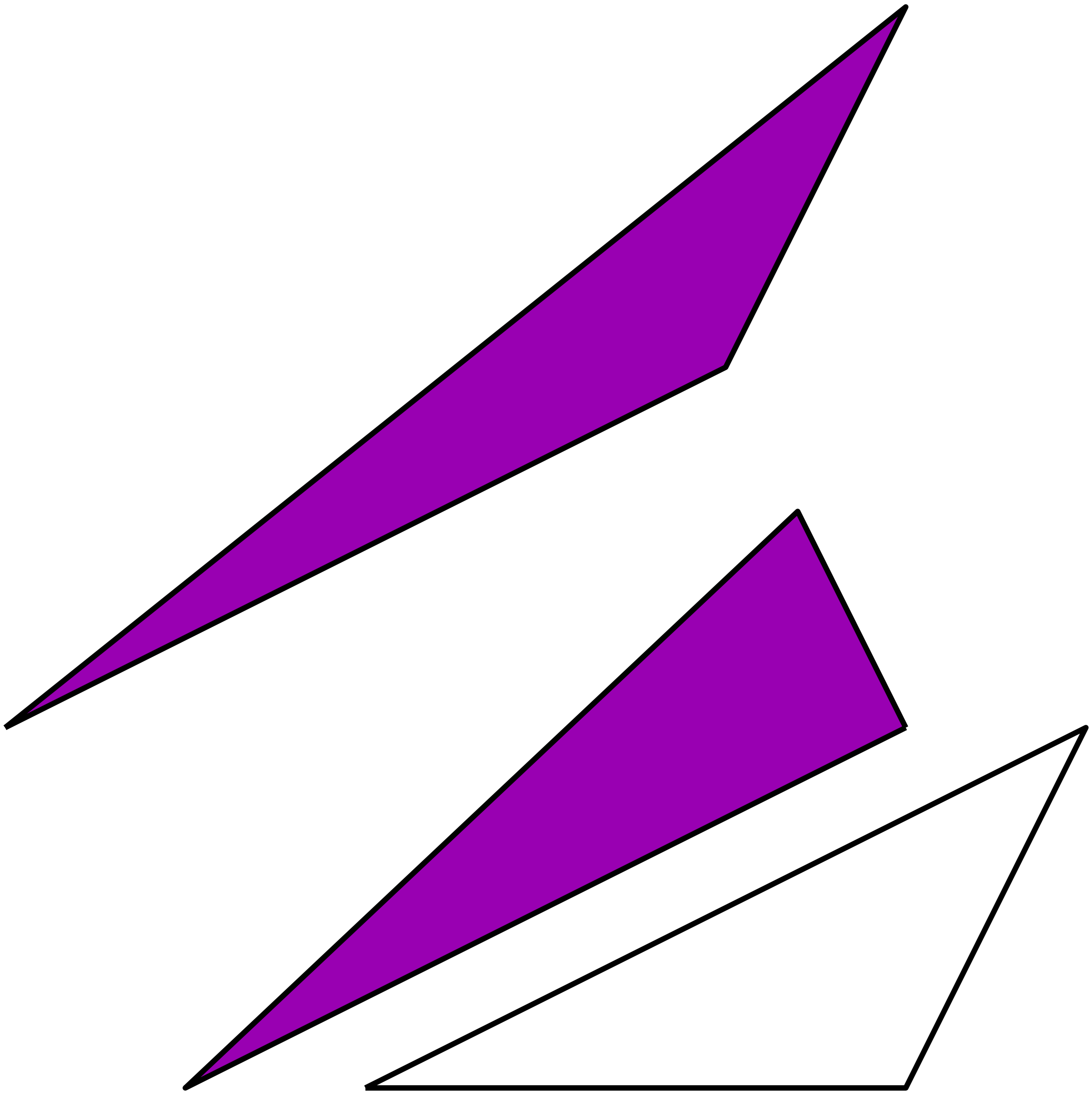


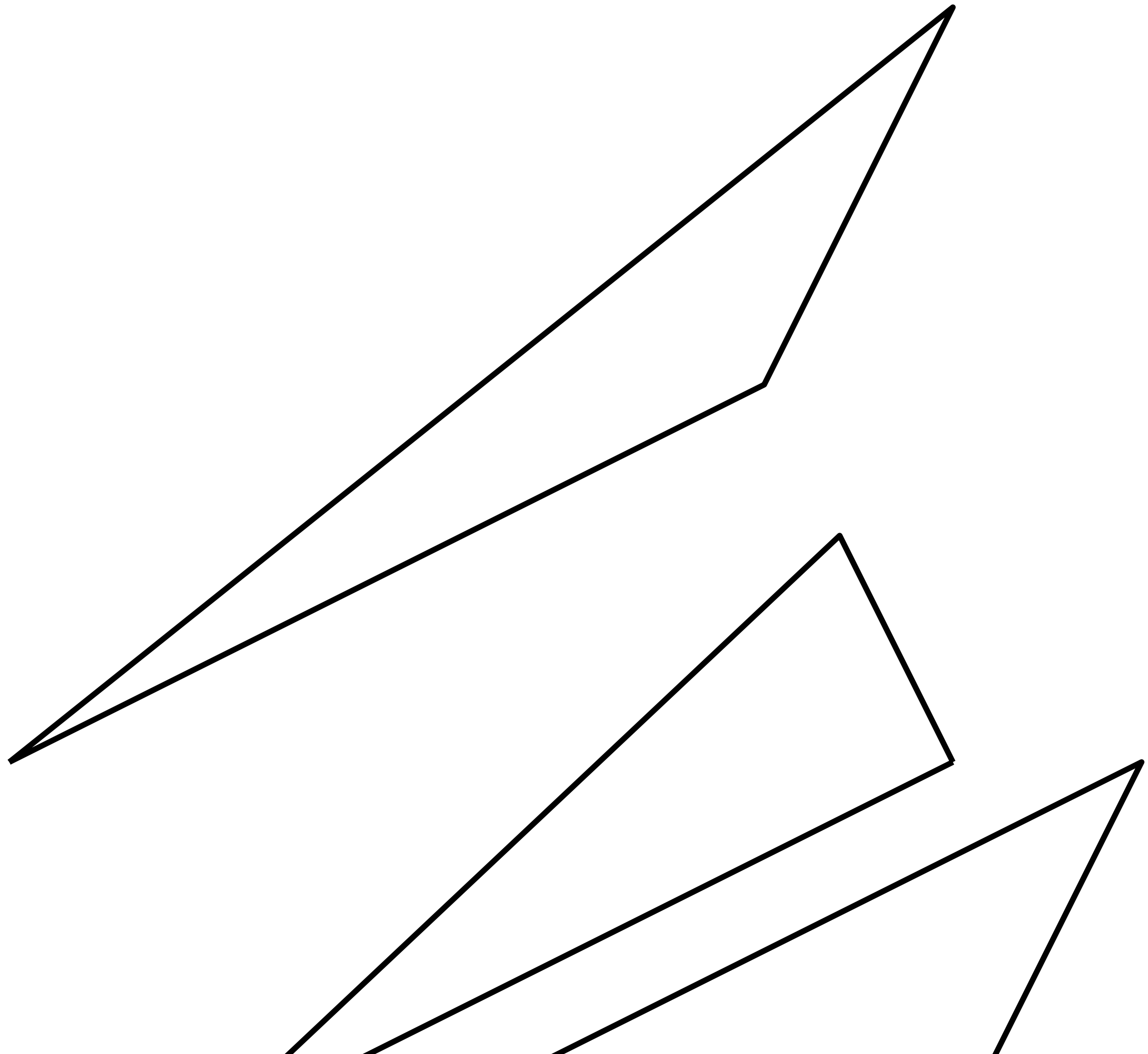
The blue areas are the same.



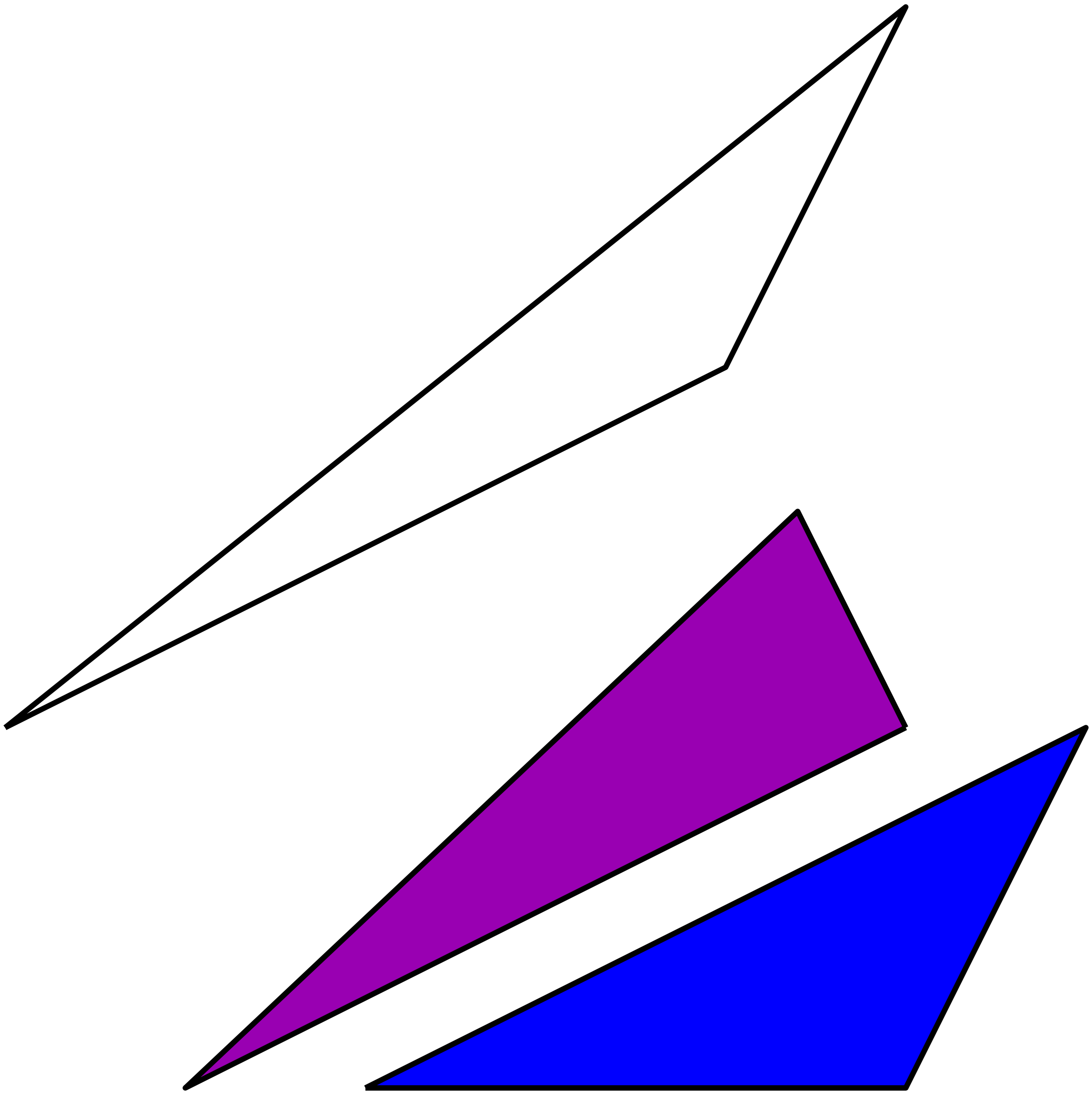


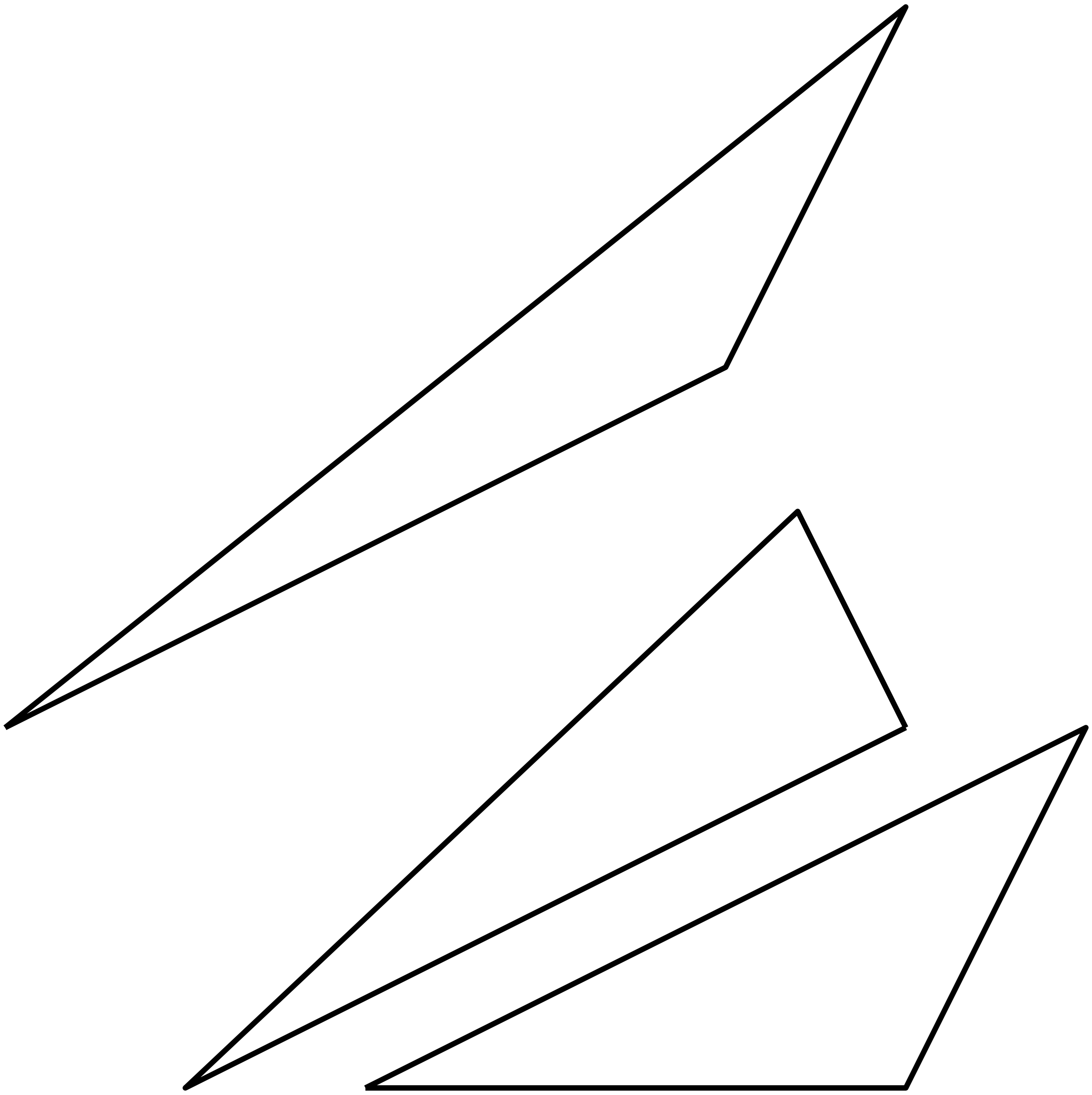
The purple areas are the same.

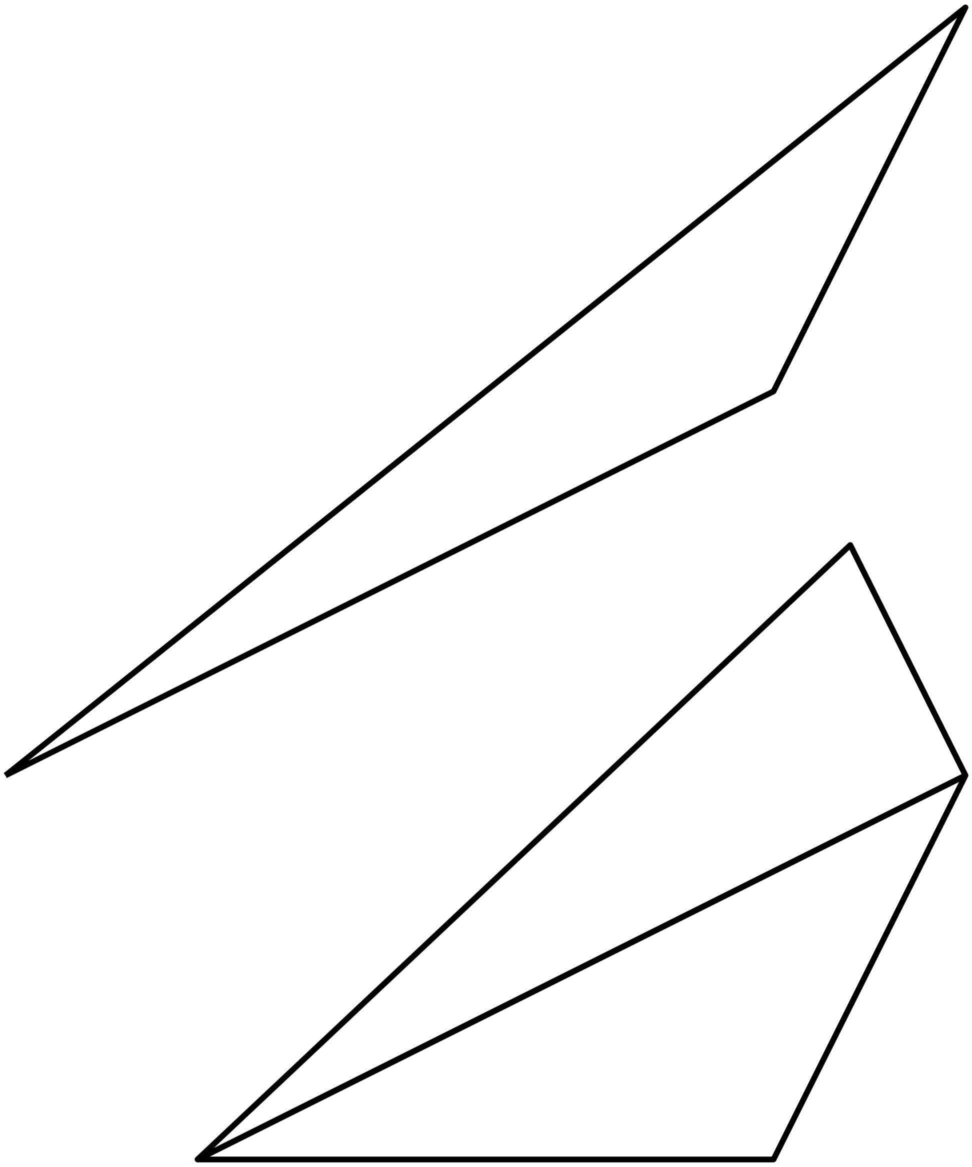


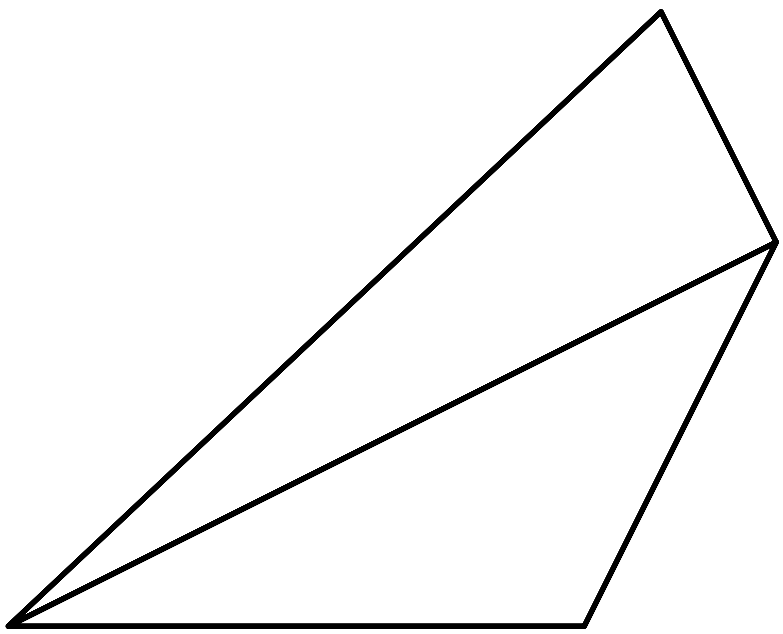


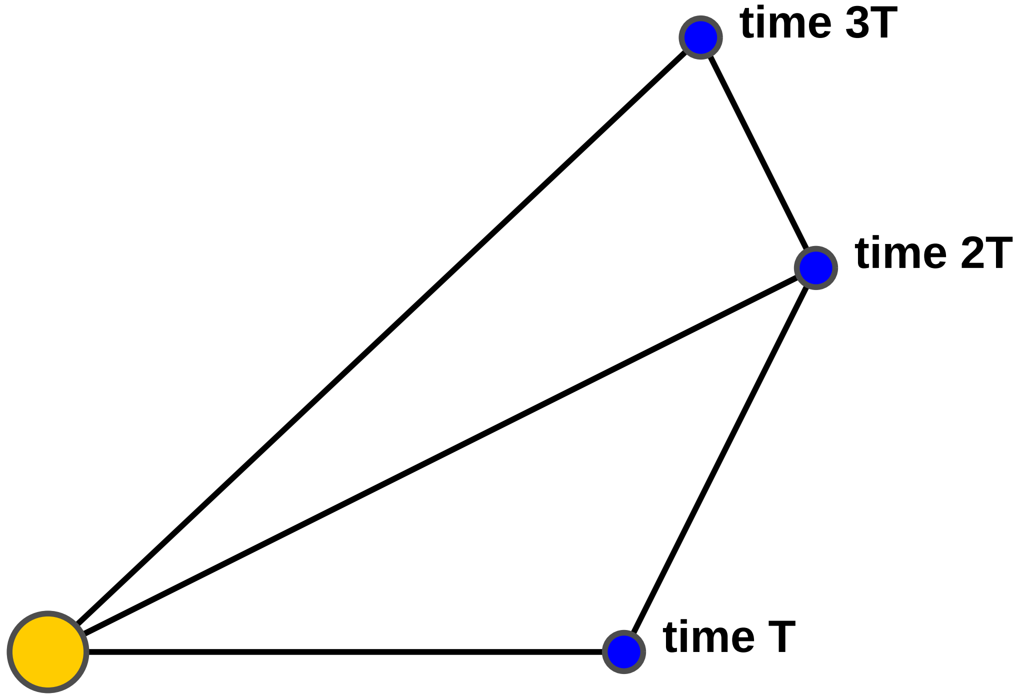
Therefore these areas are the same.



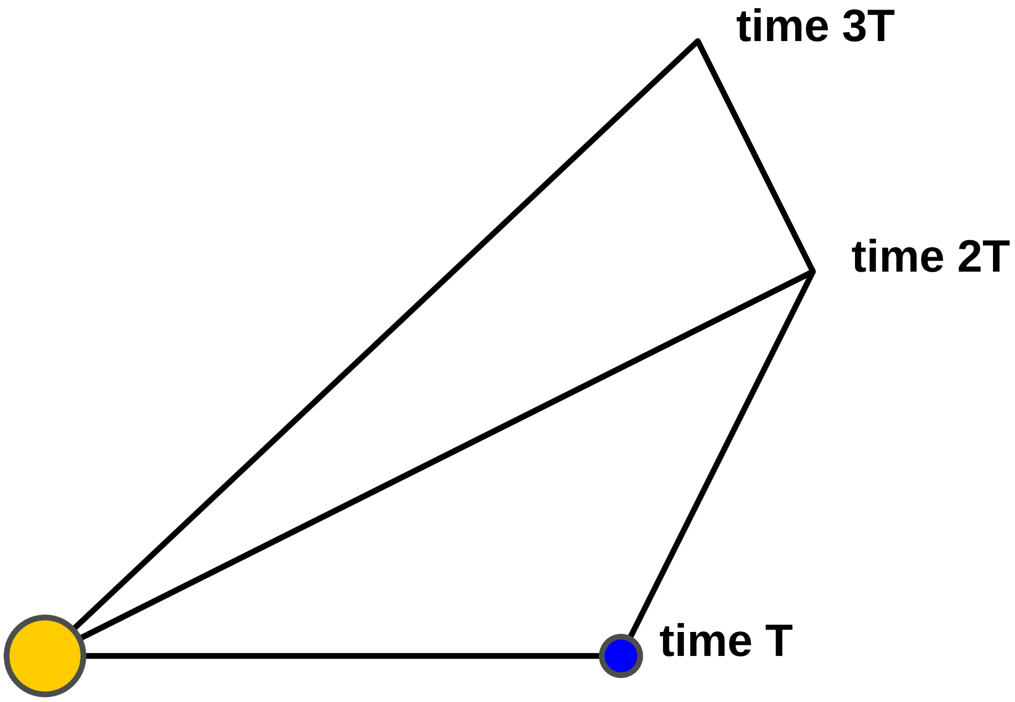




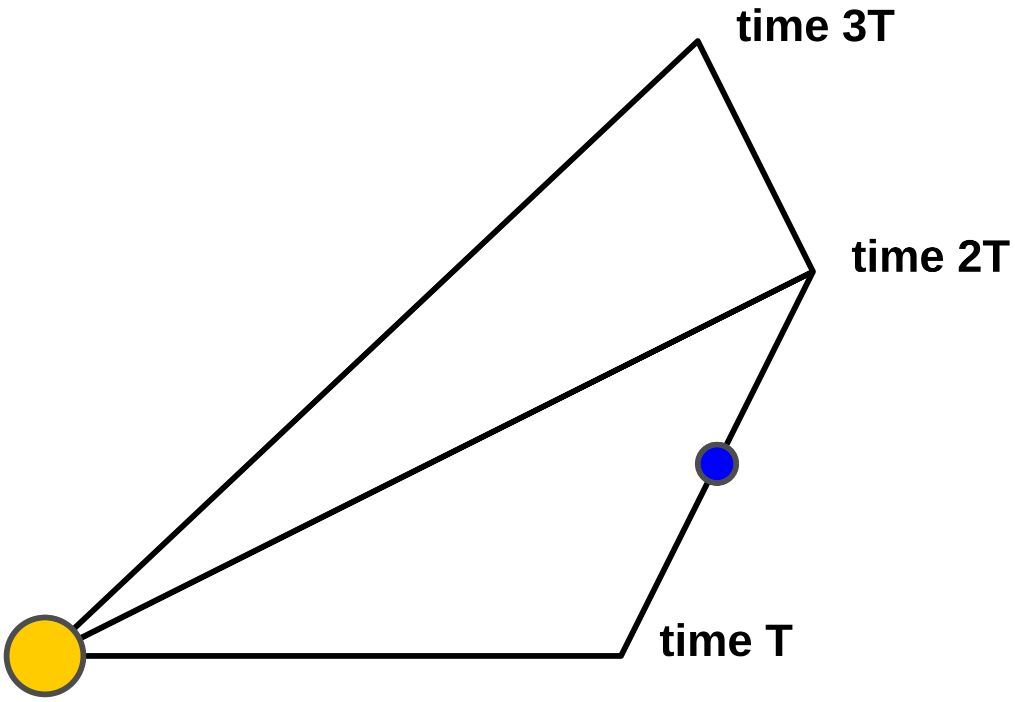



time 3T
time 2T
time T

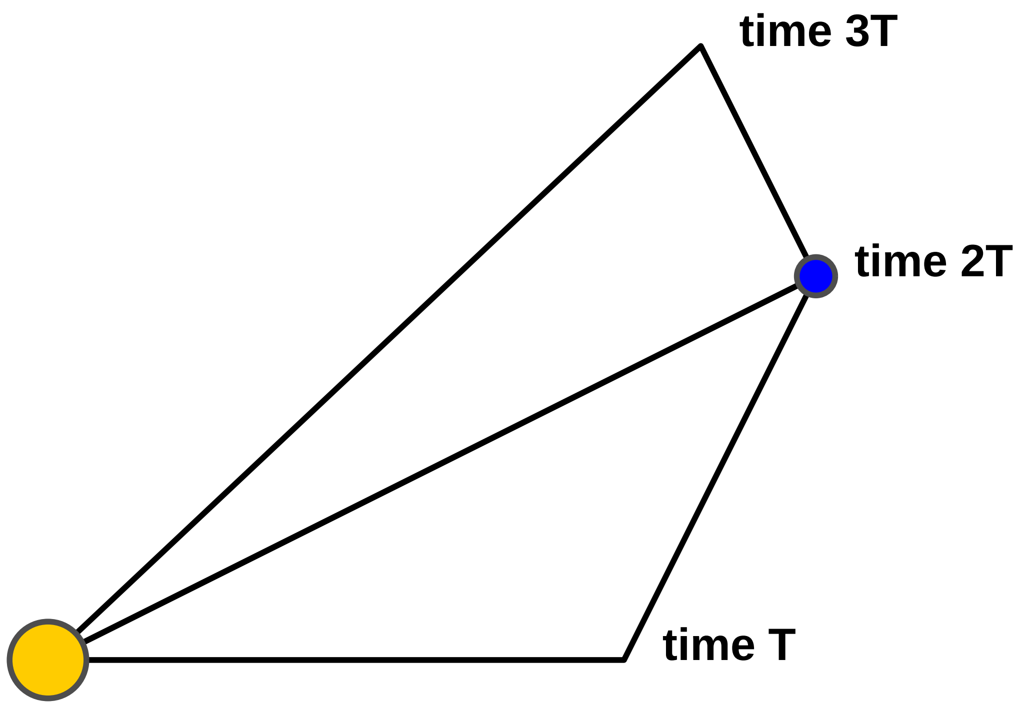
The planet moves so that the two triangles have equal areas in equal times.



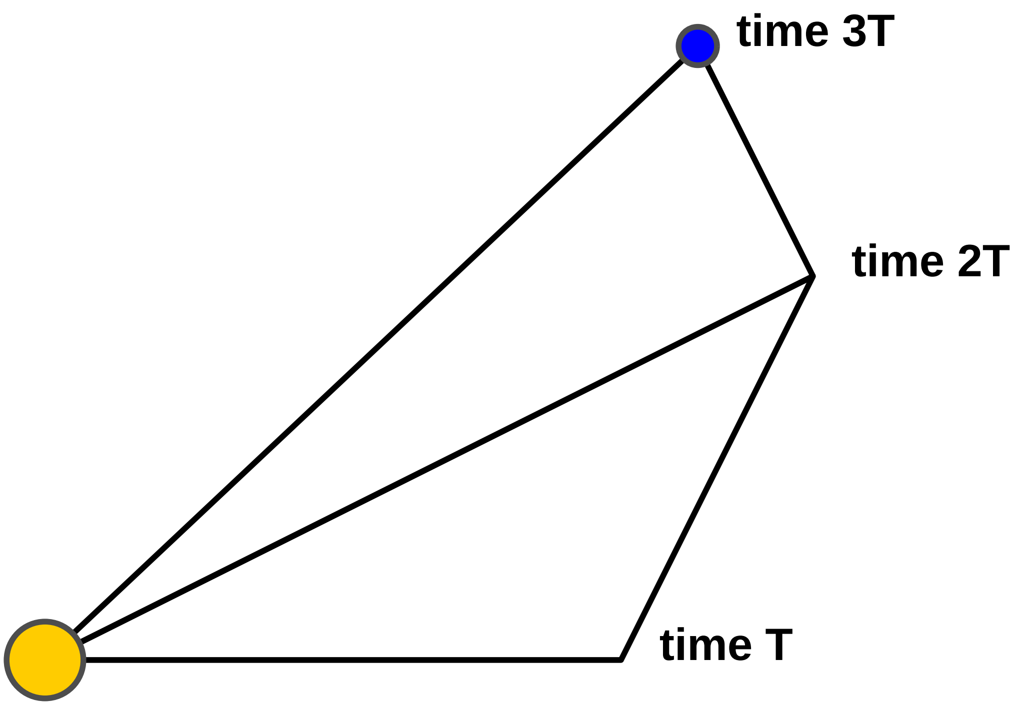
The planet moves so that the two triangles have equal areas in equal times.

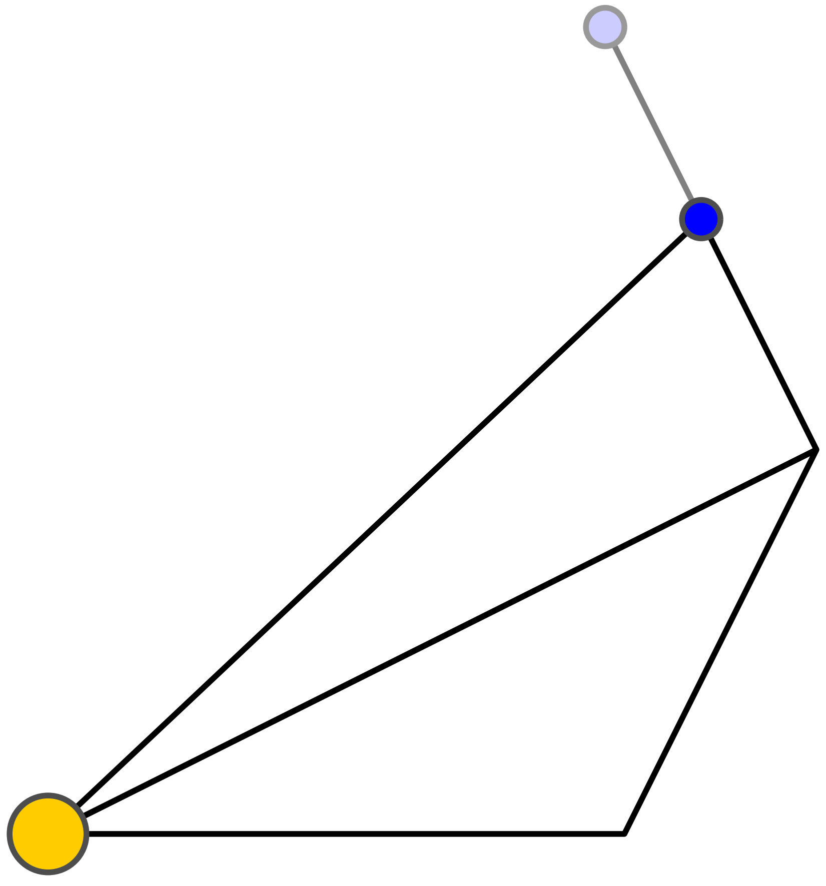


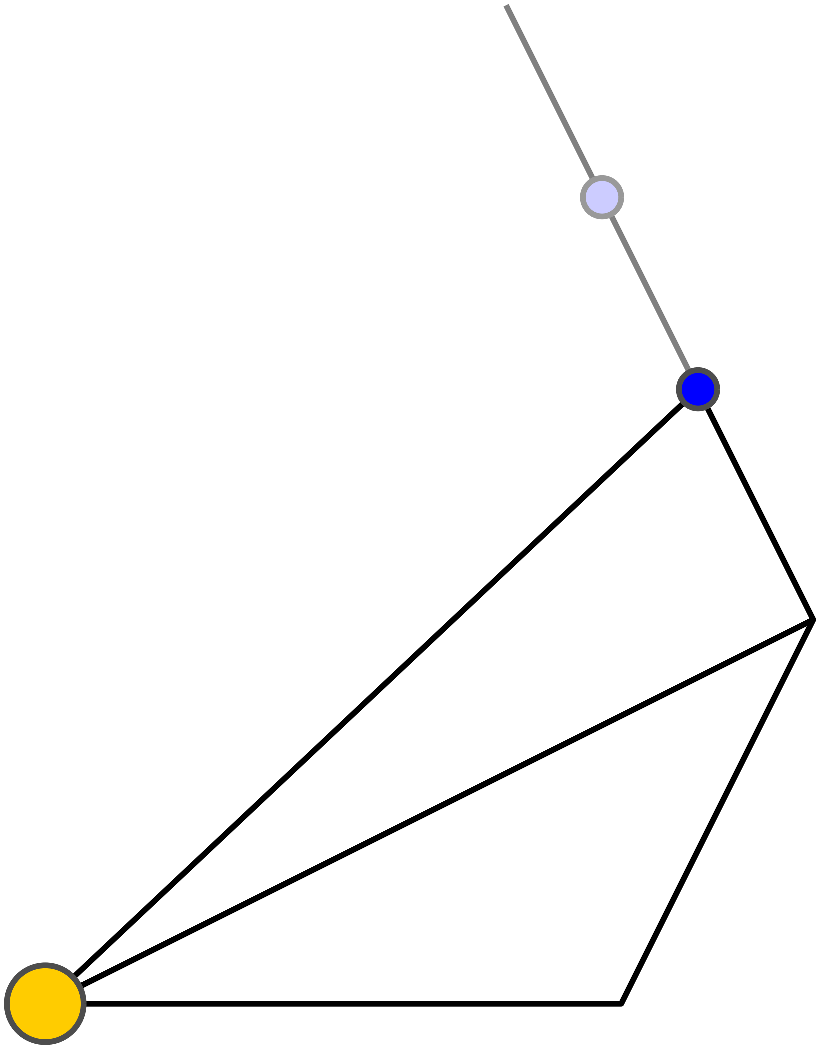
The planet moves so that the two triangles have equal areas in equal times.

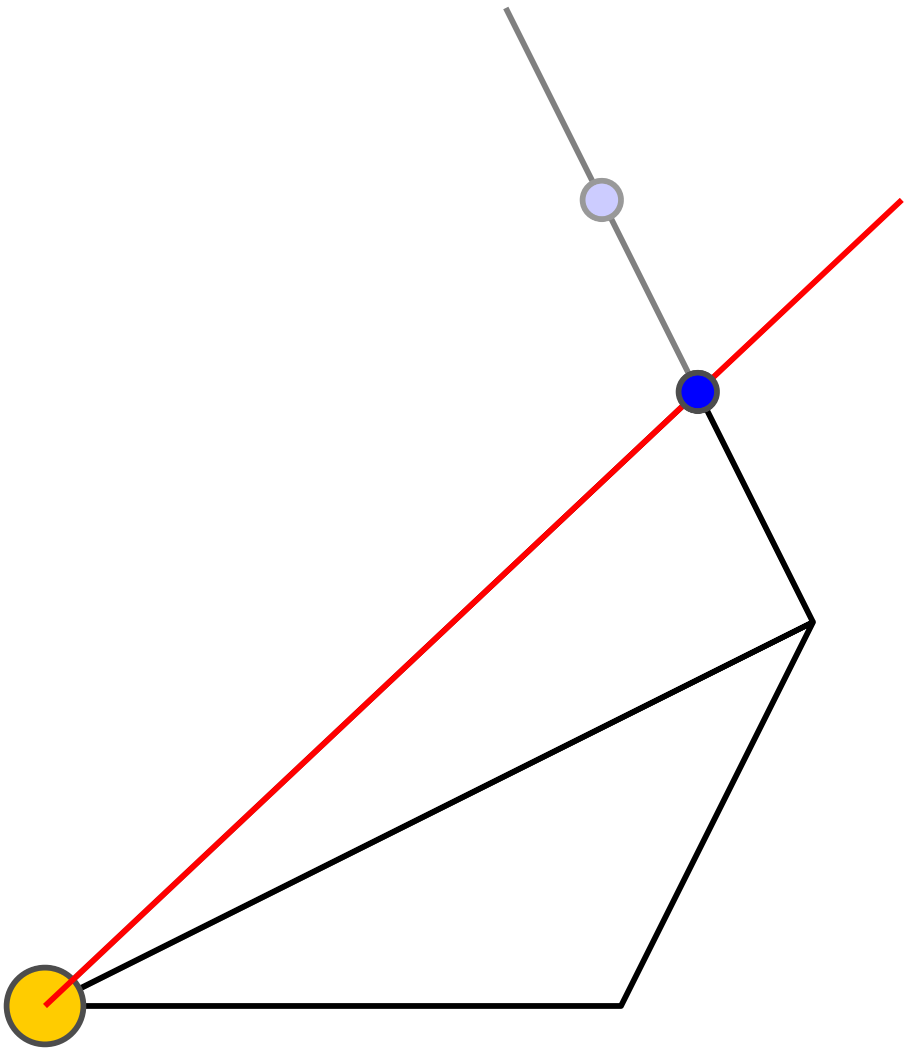


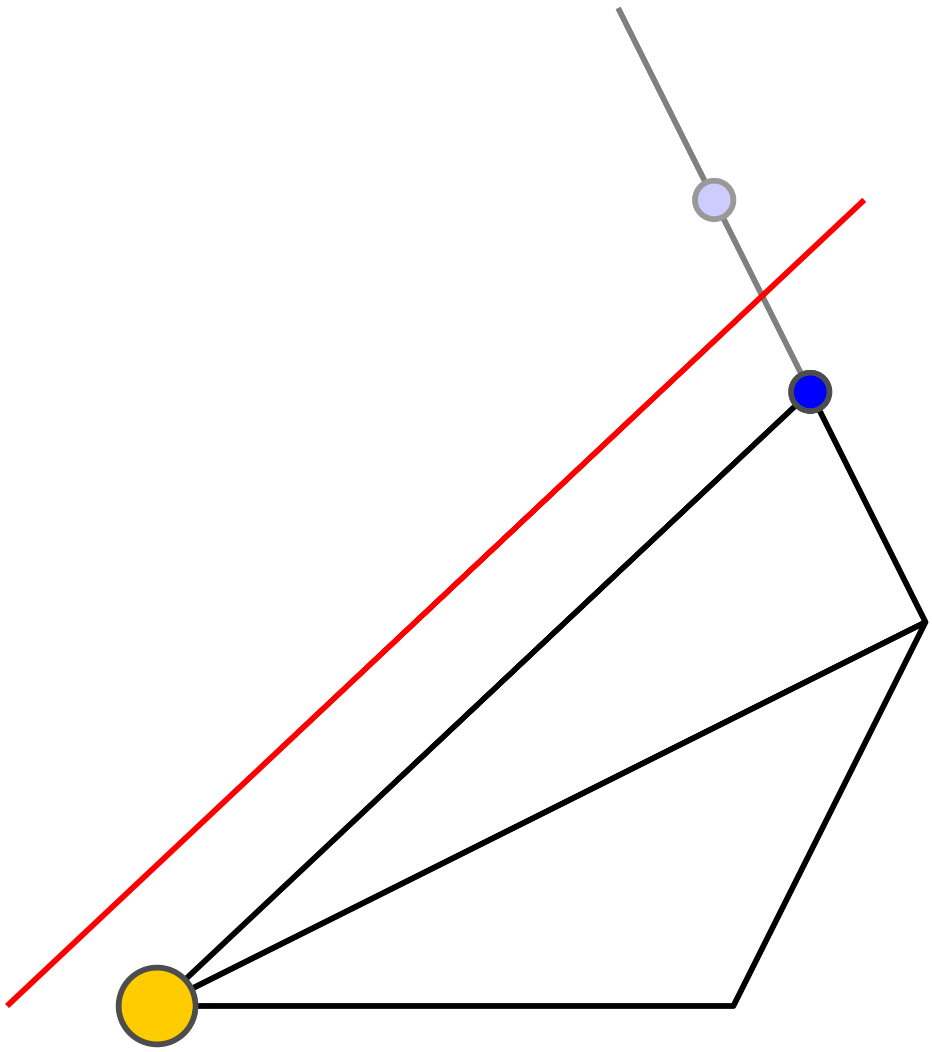
The planet moves so that the two triangles have equal areas in equal times.

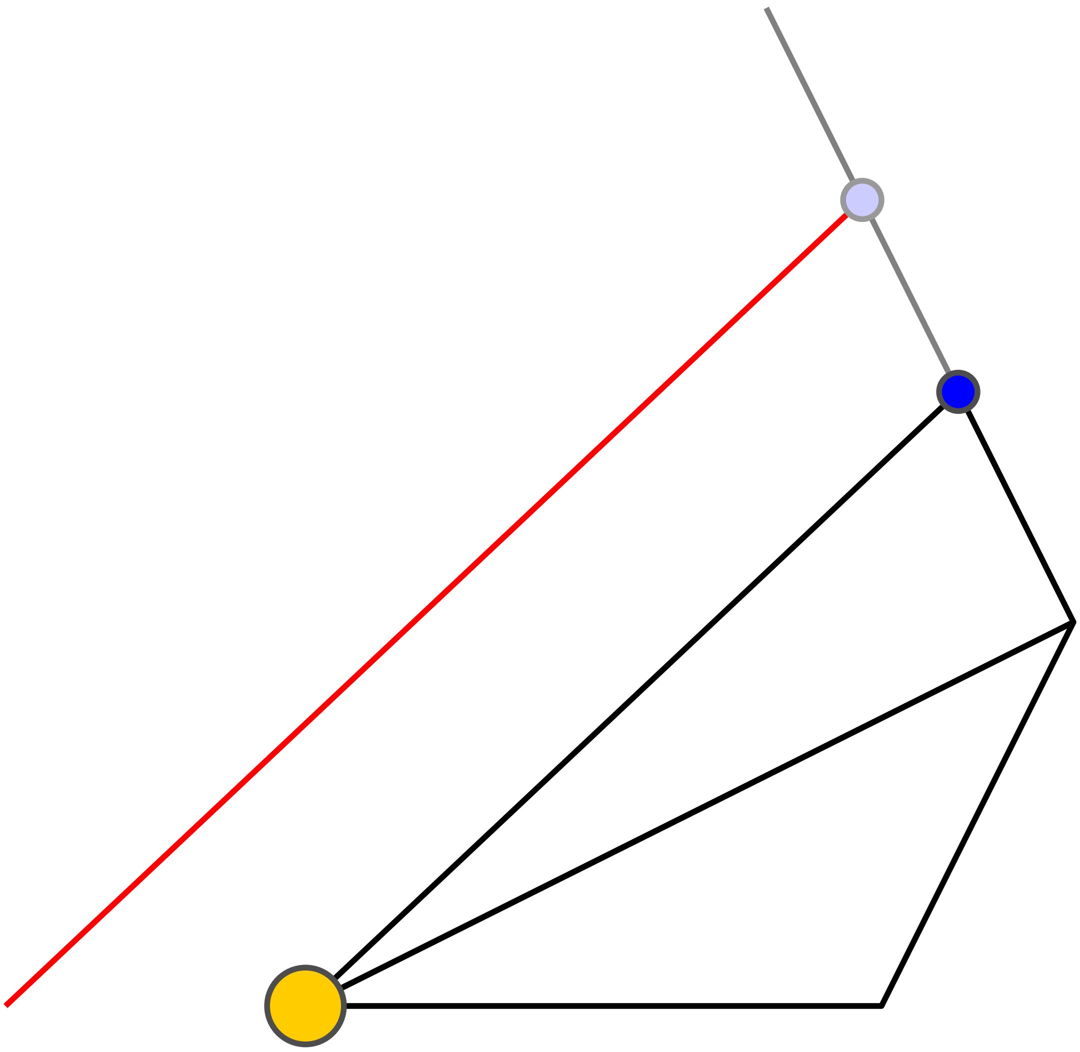


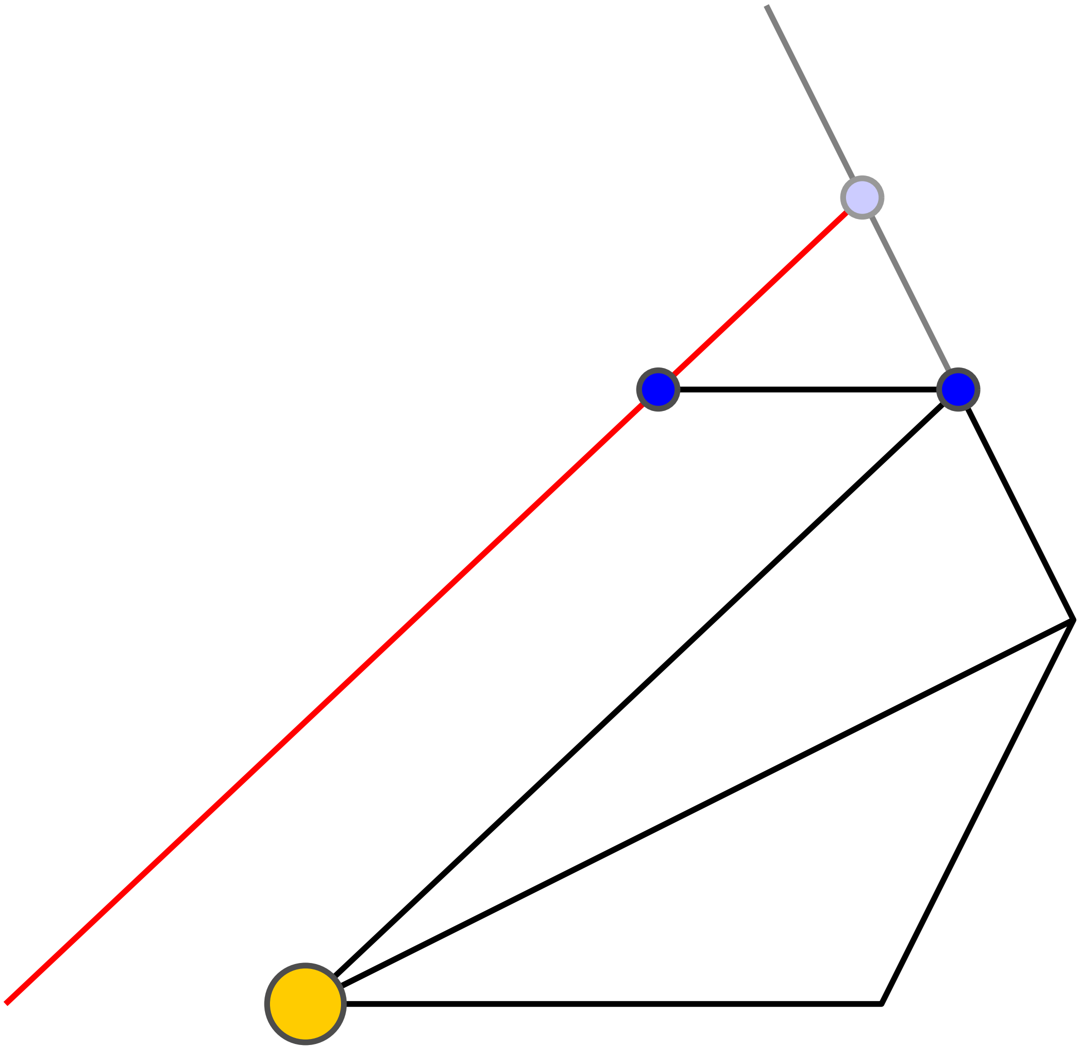


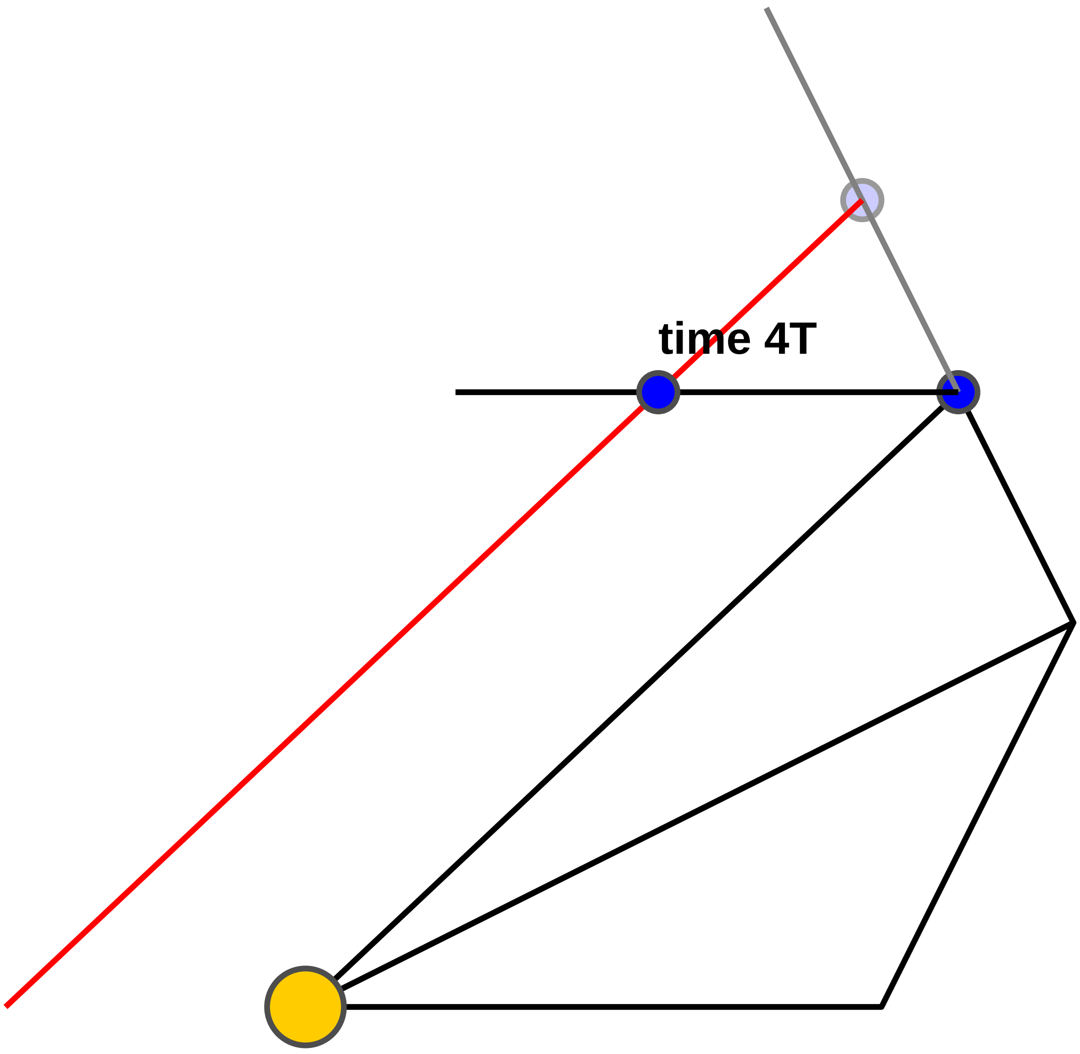


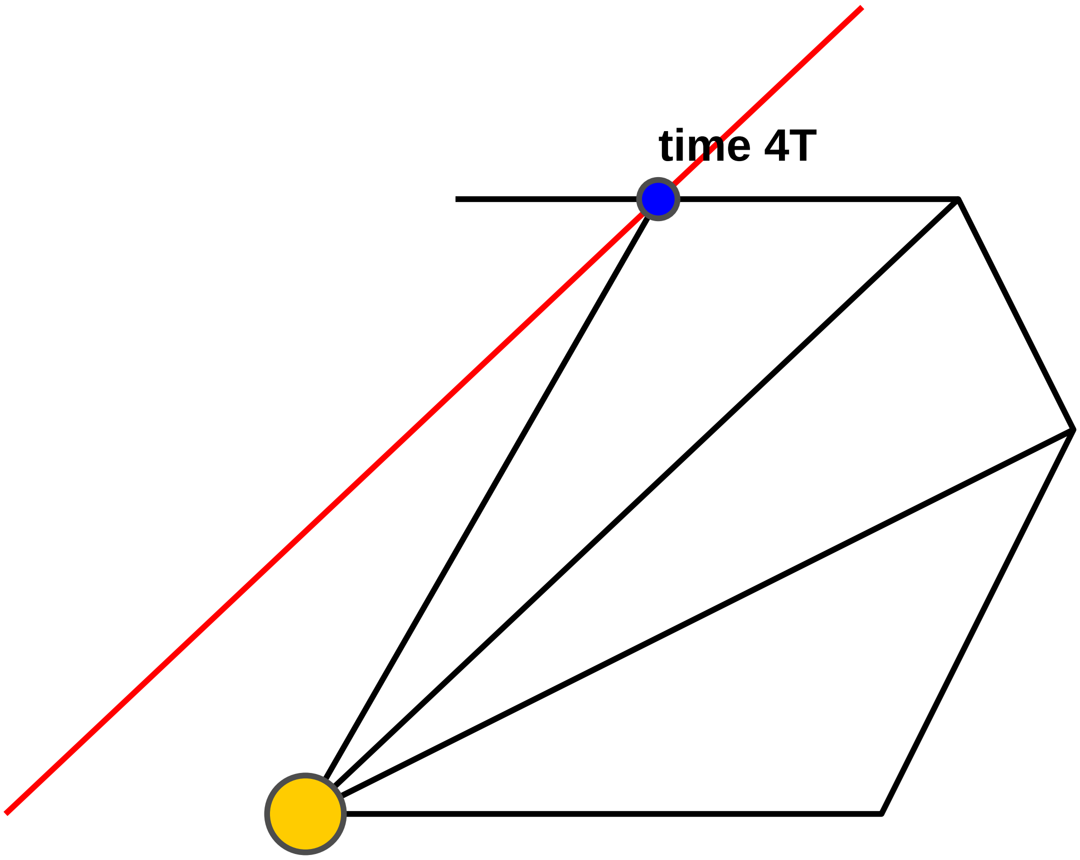


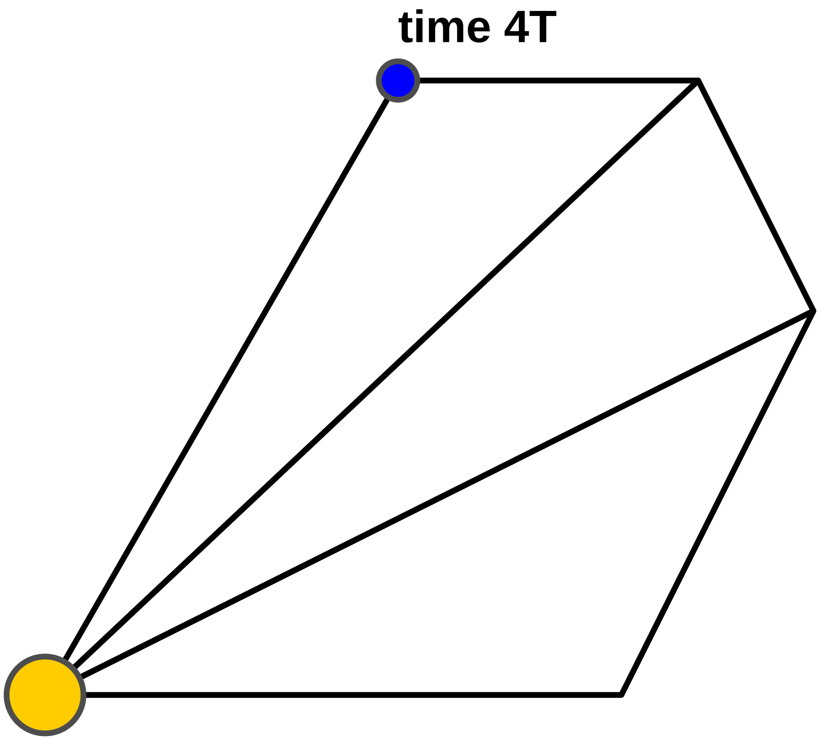


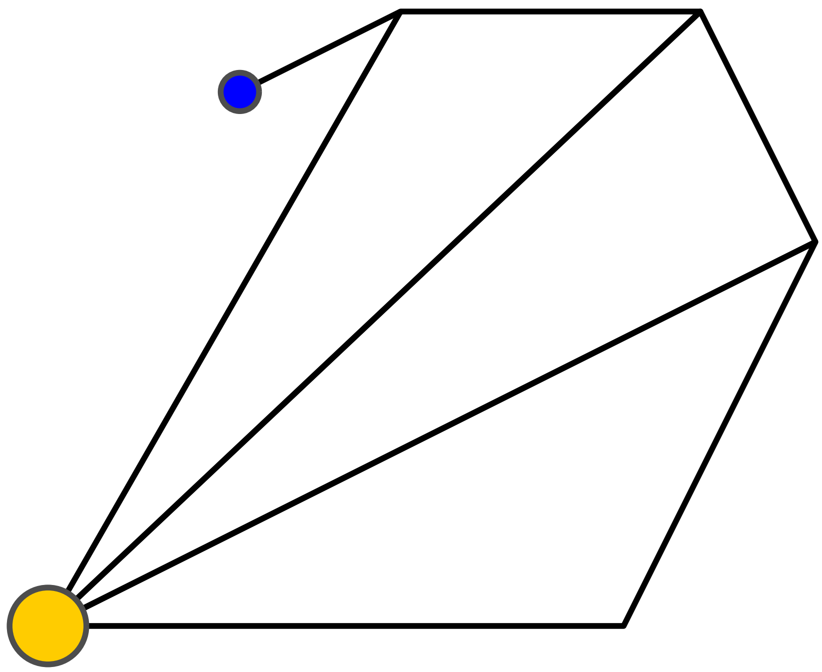


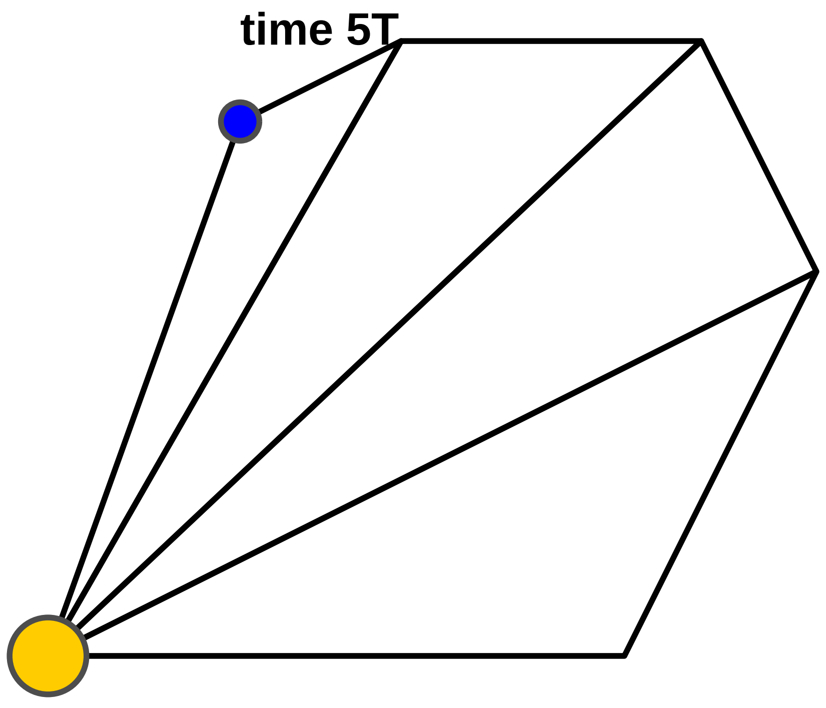



time 4T

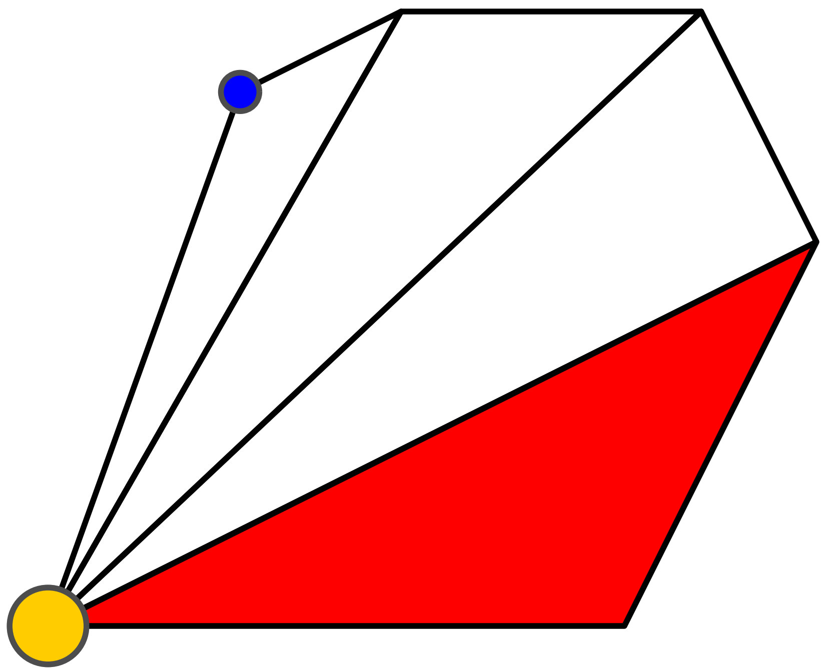

time 4T


time 4T

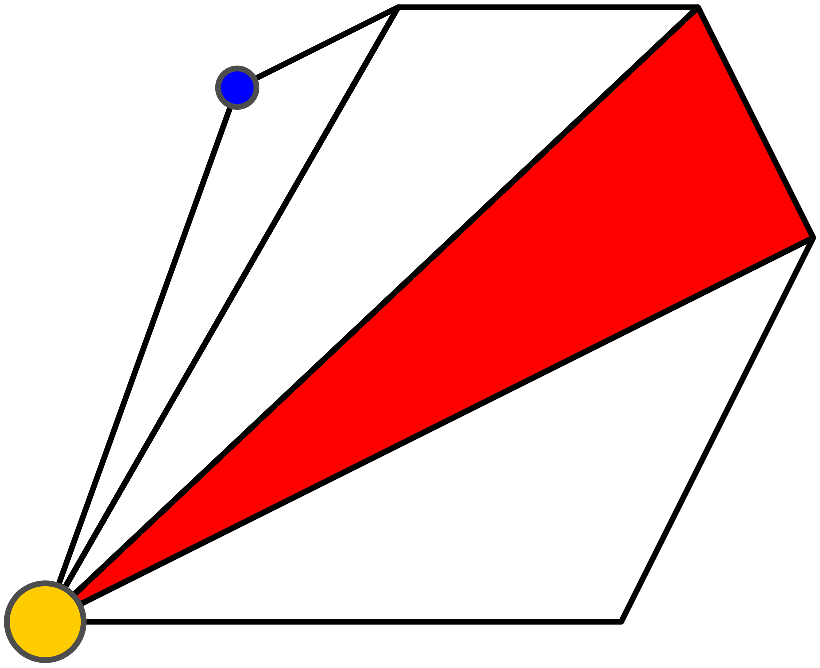



time 5T

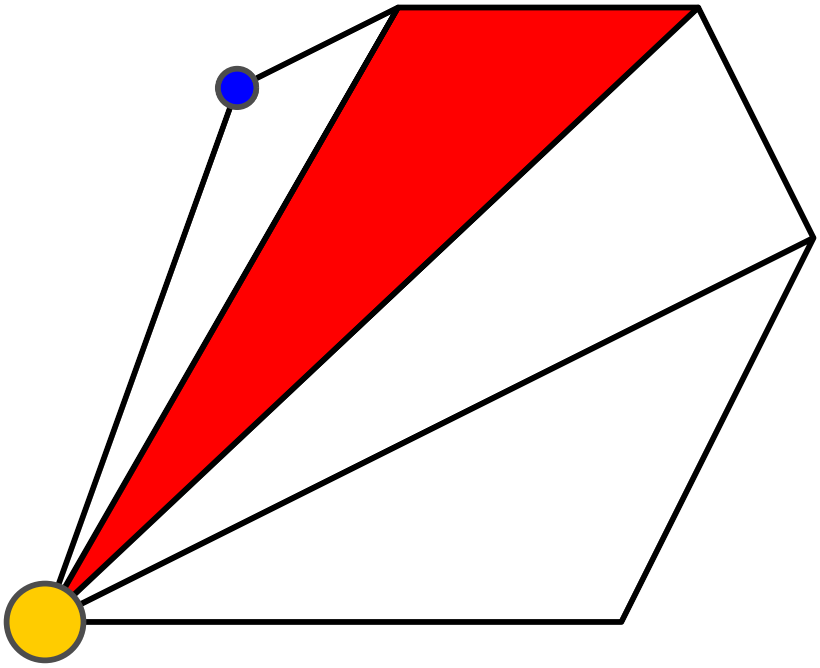
Each of these areas are equal each other.



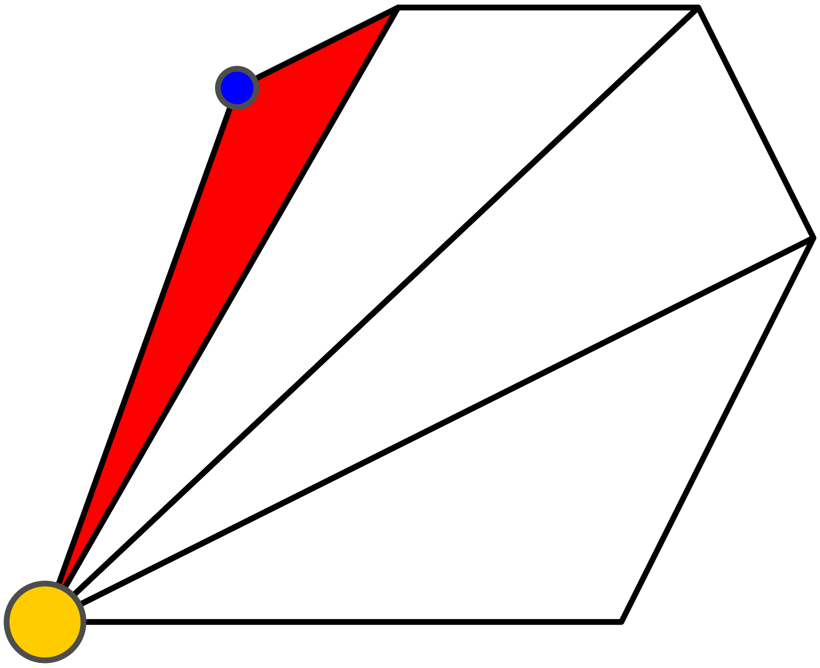
Each of these areas are equal each other.

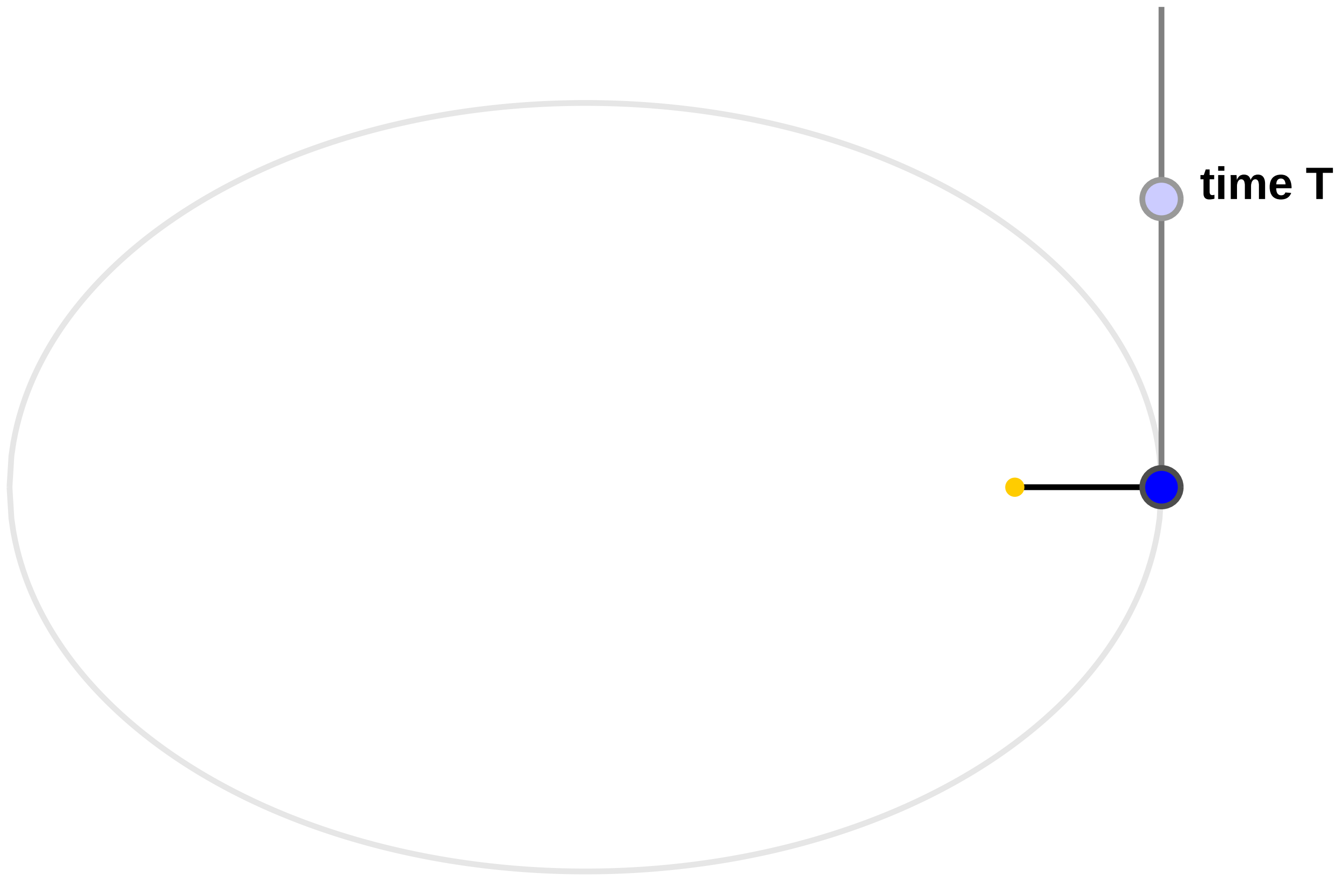


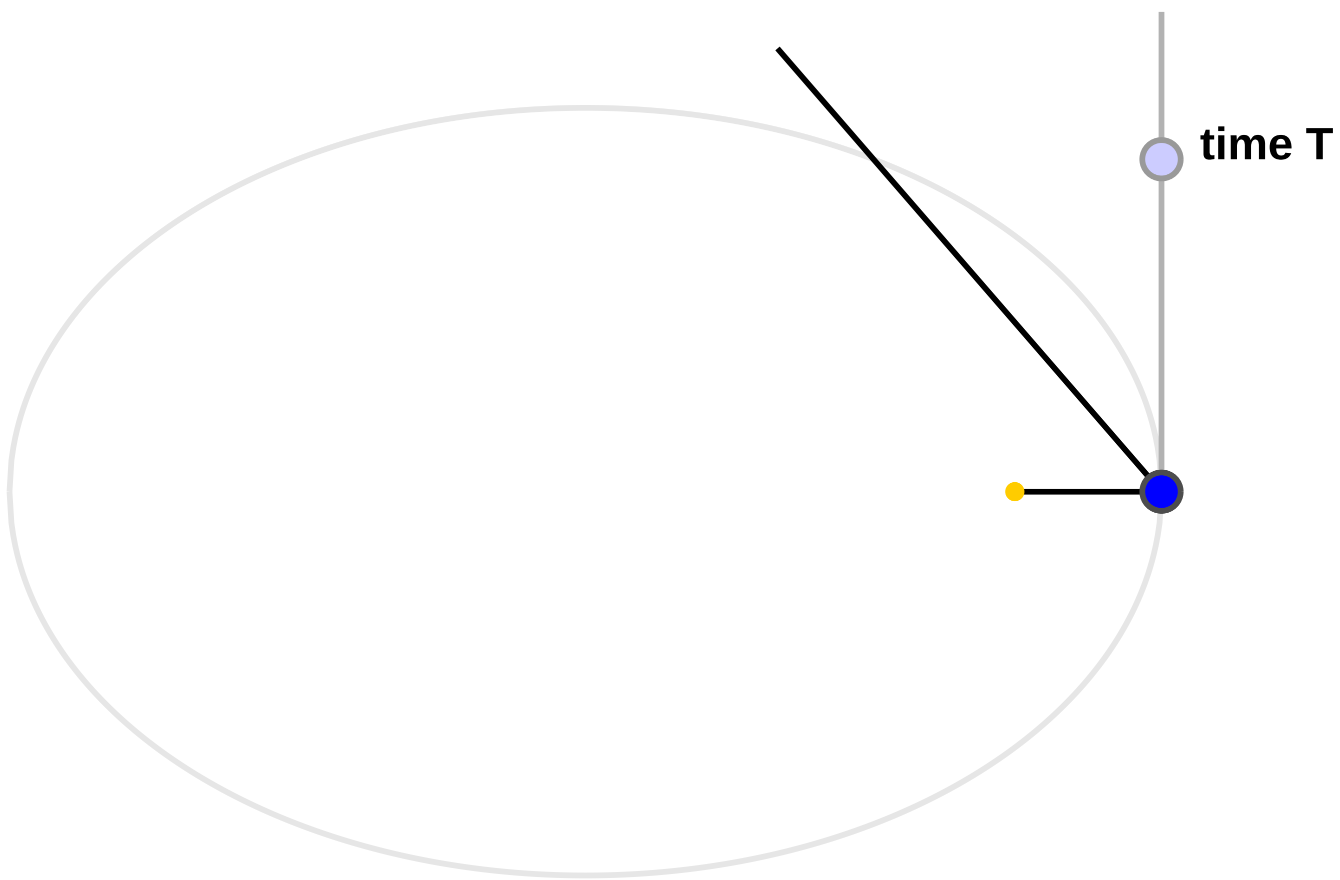
Each of these areas are equal each other.

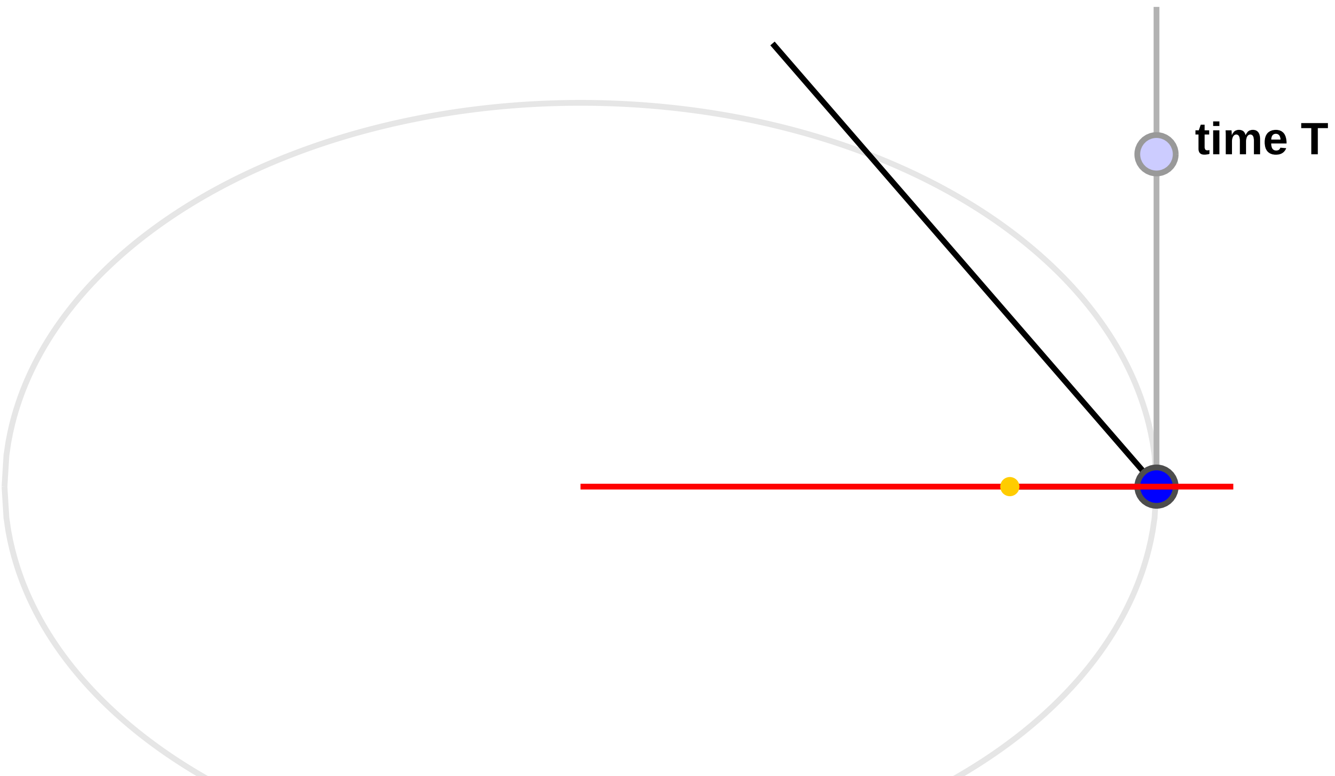


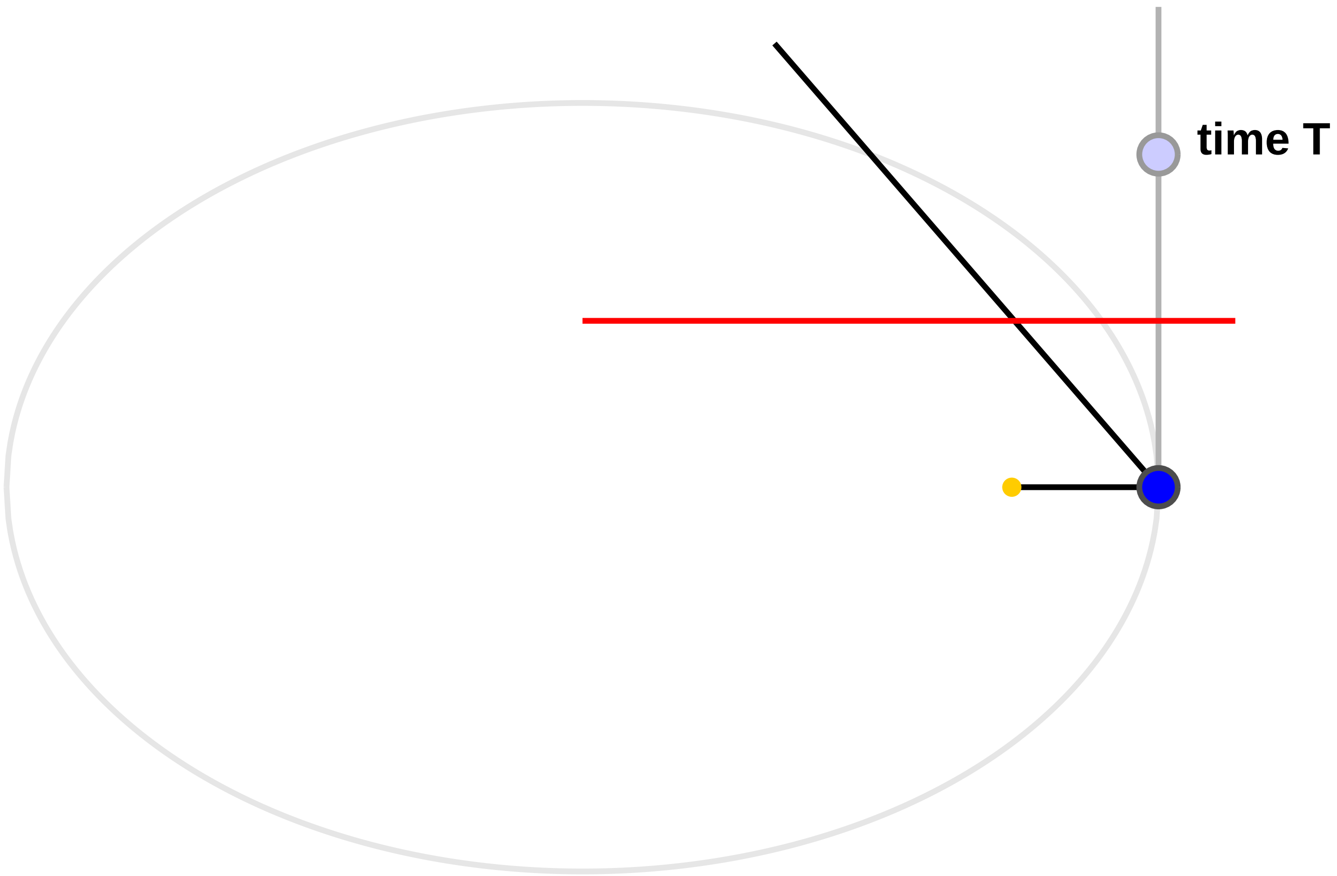
Each of these areas are equal each other.

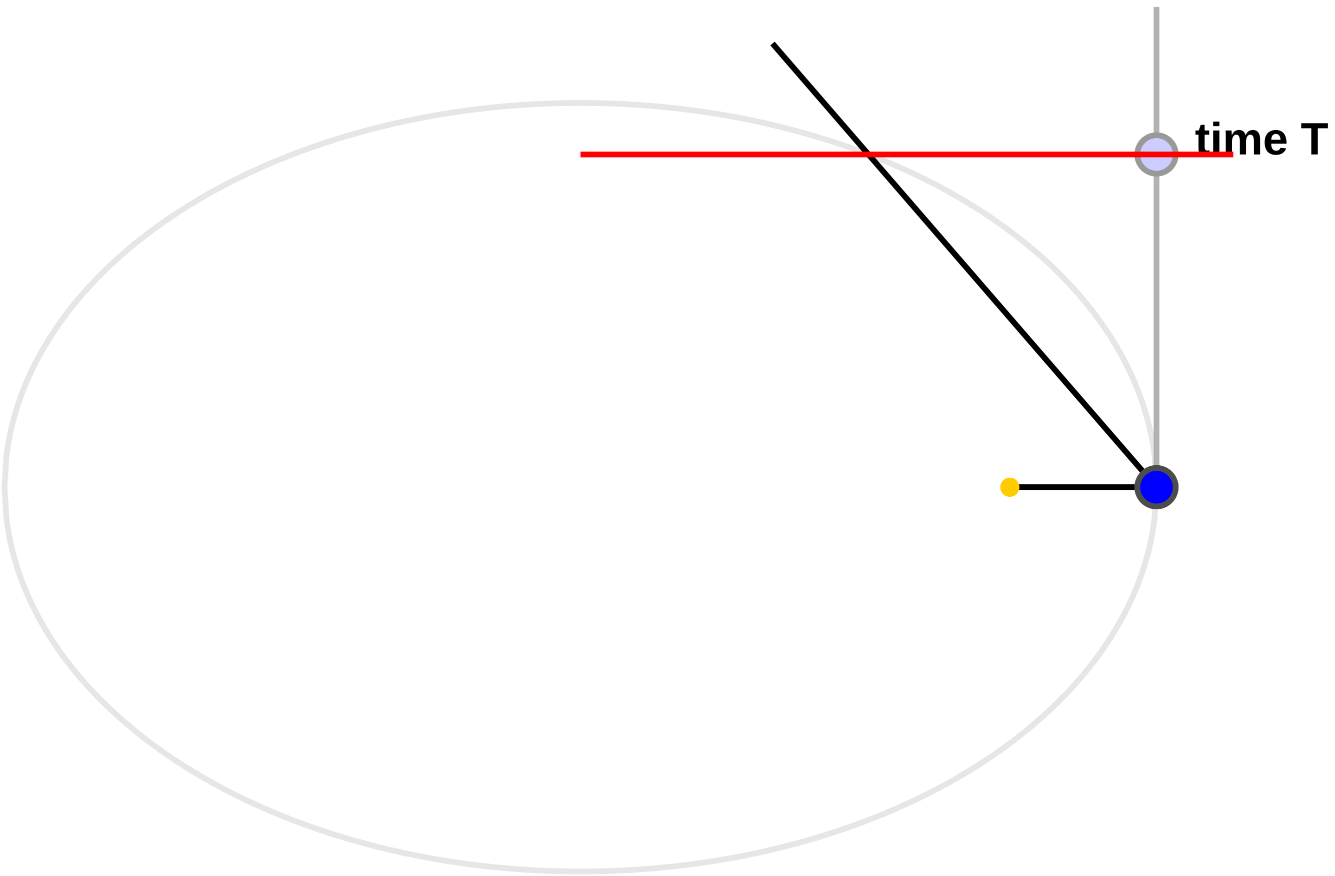


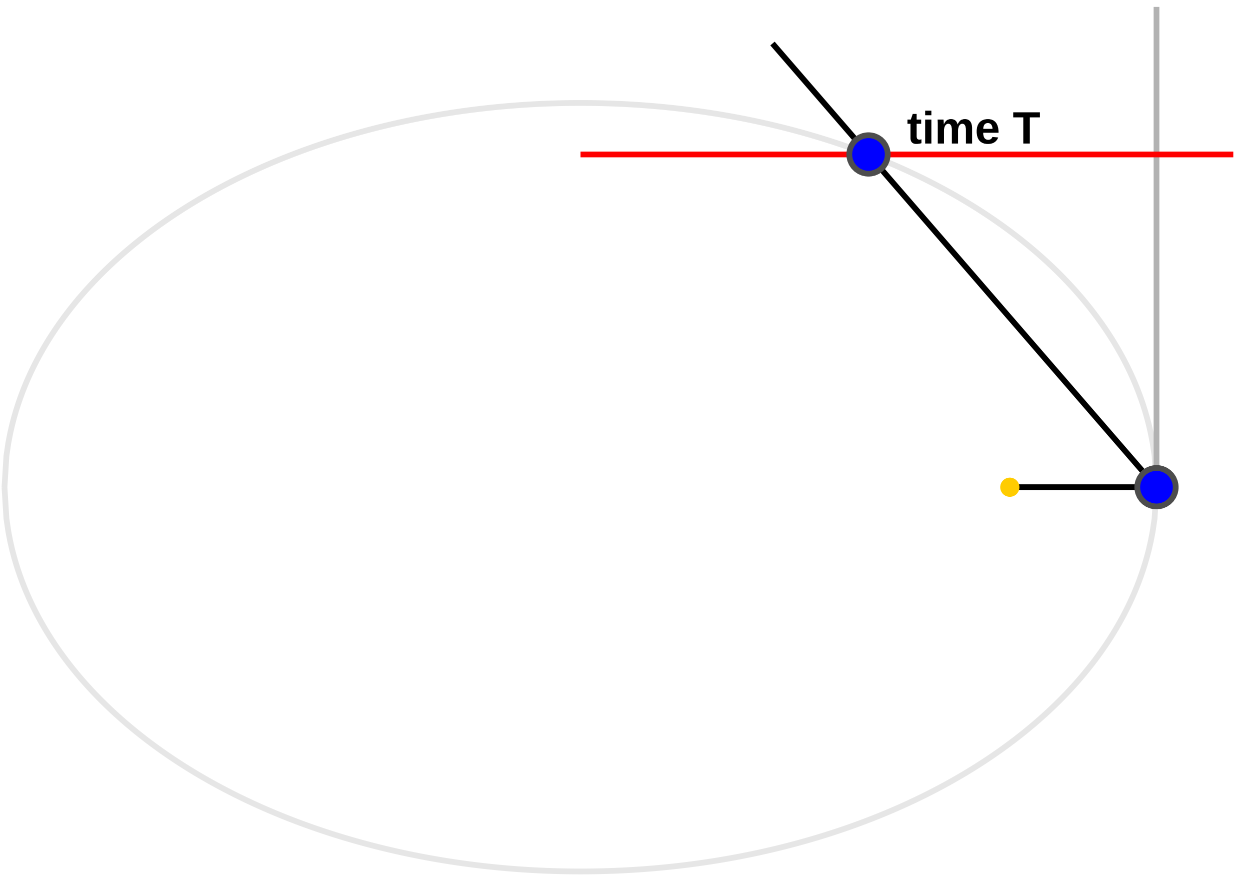

time T

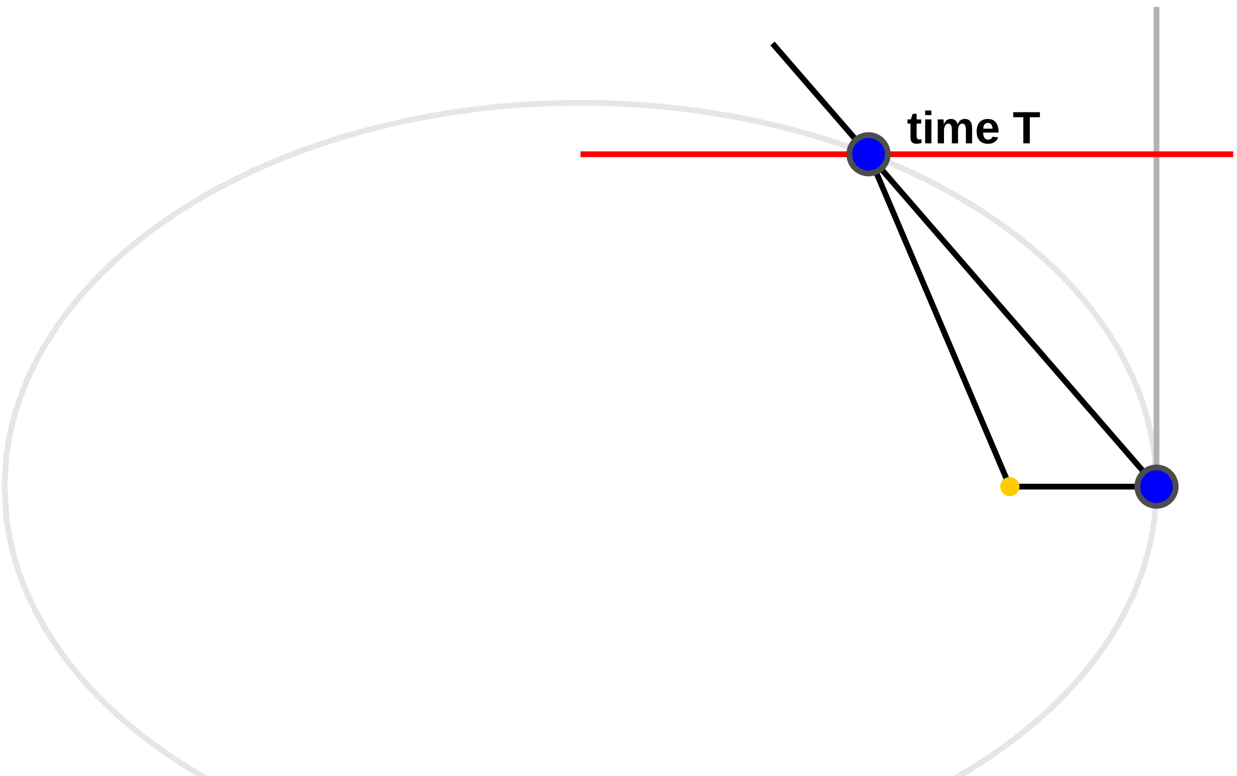

time T

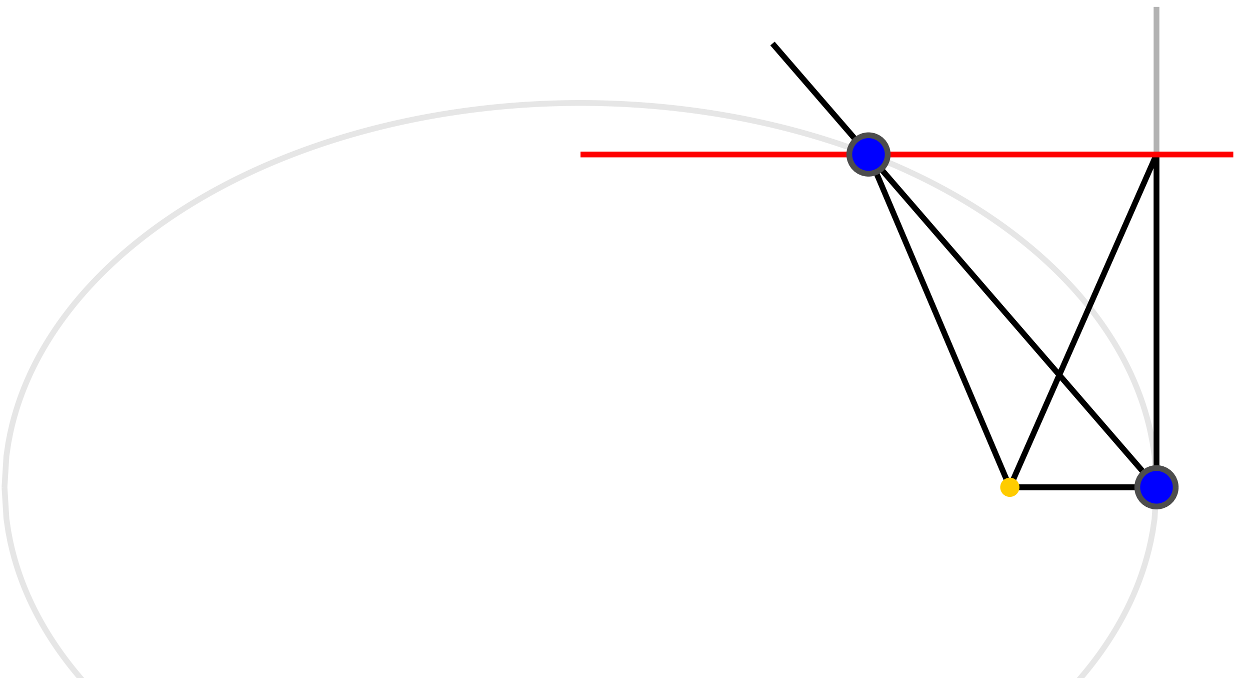

time T

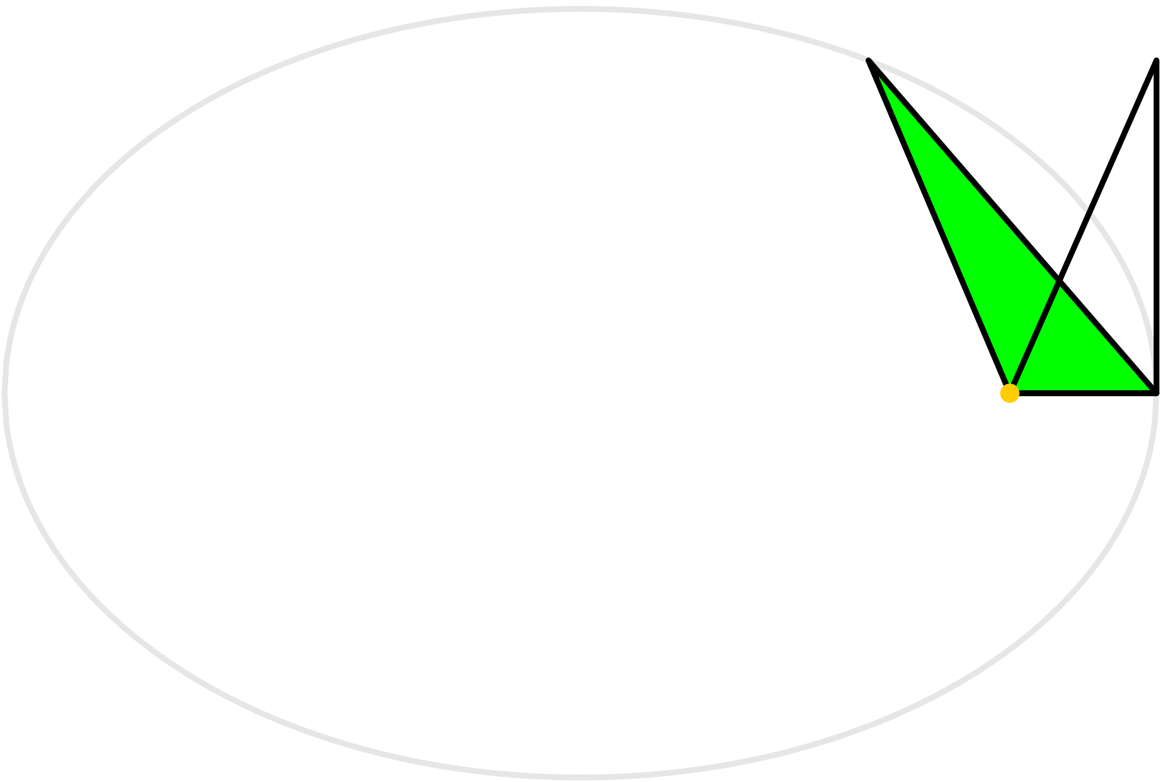

time T

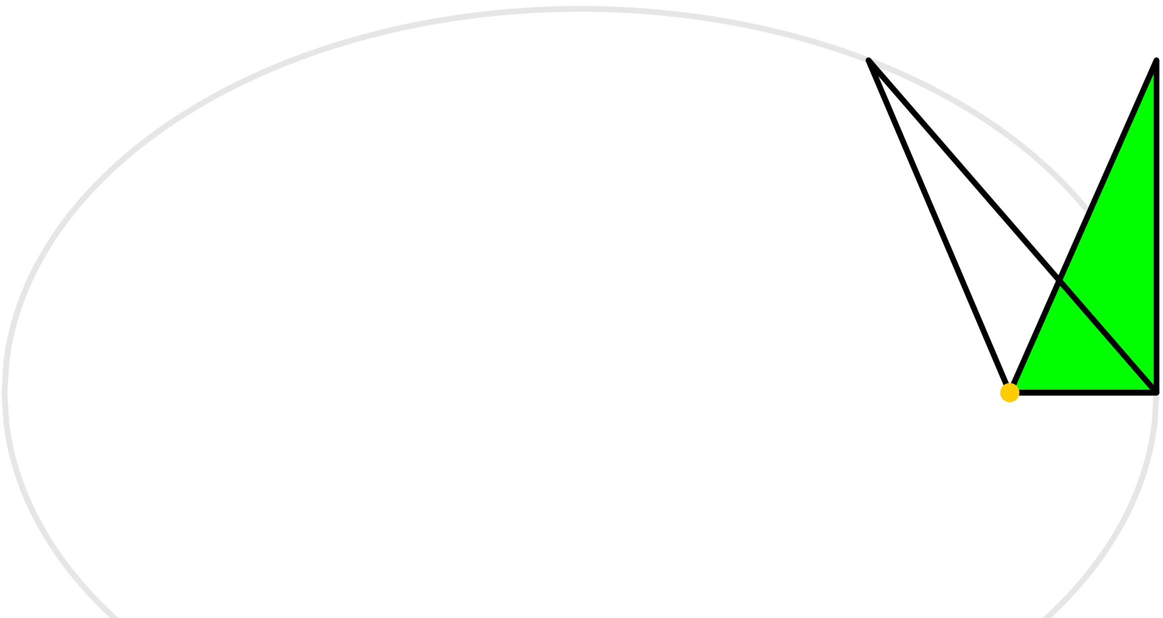

time T

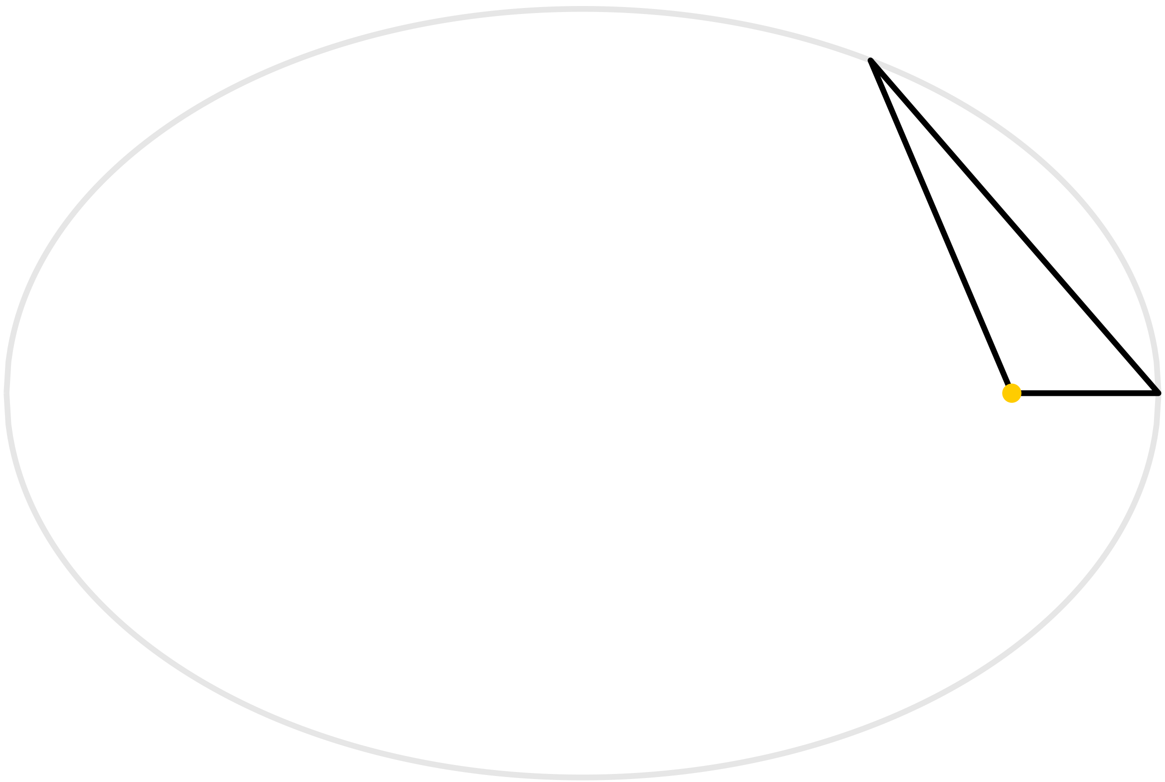

time T

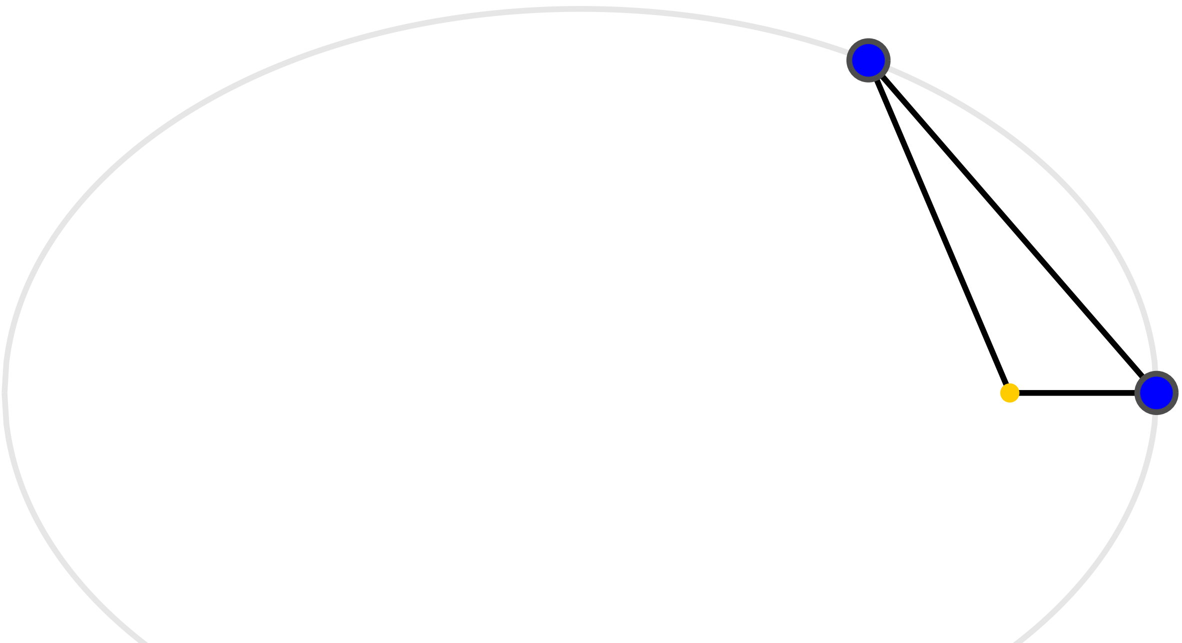

time T

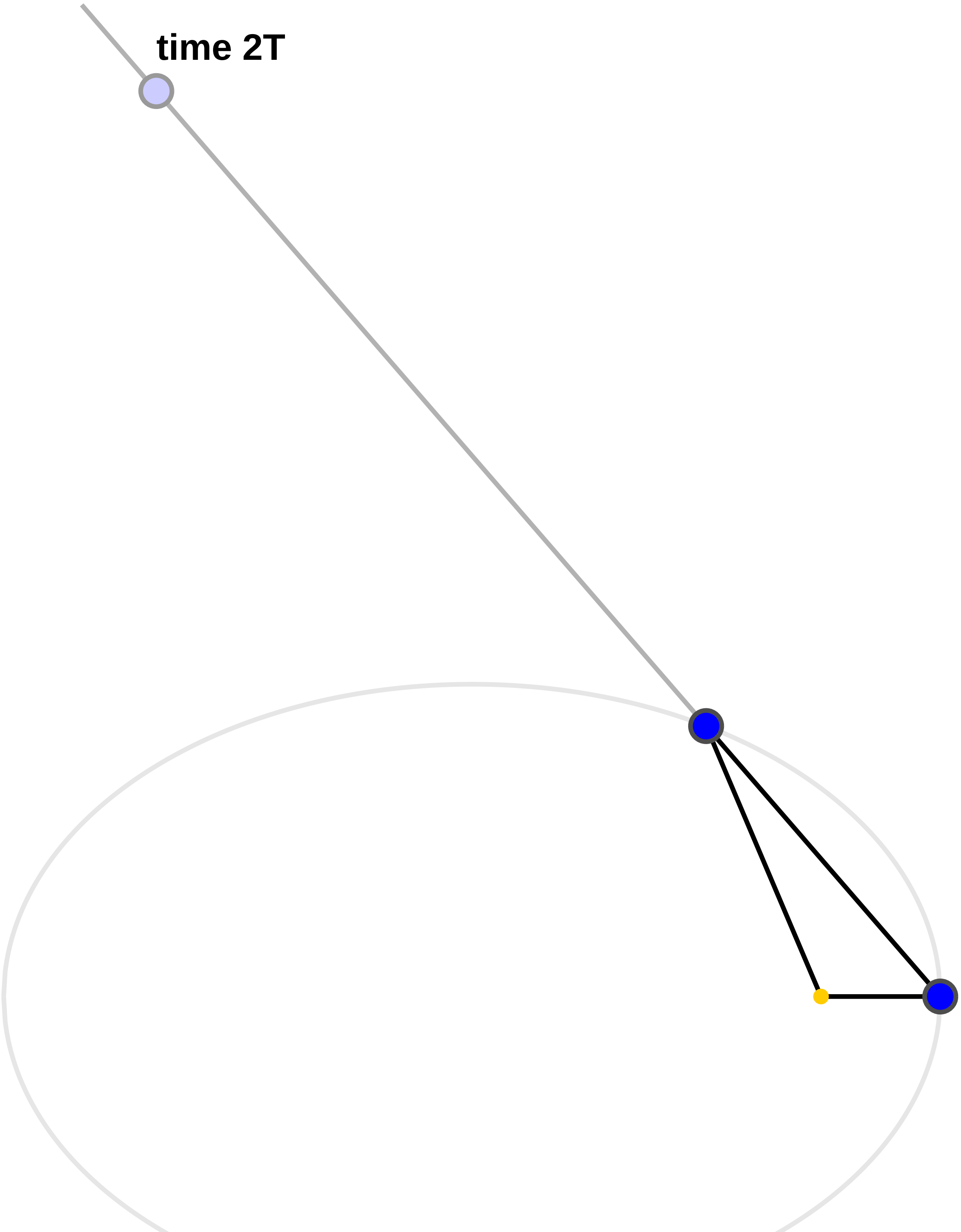


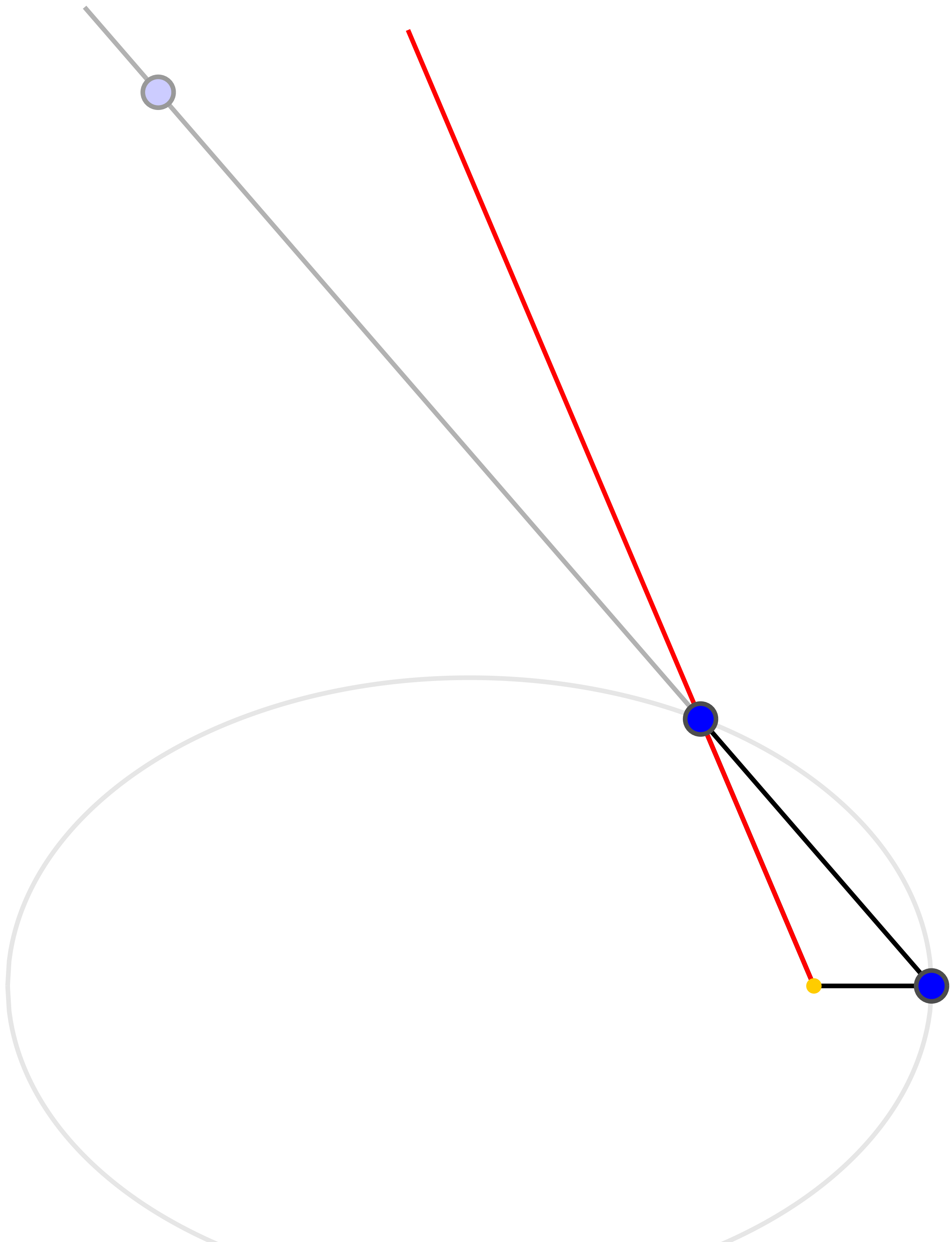


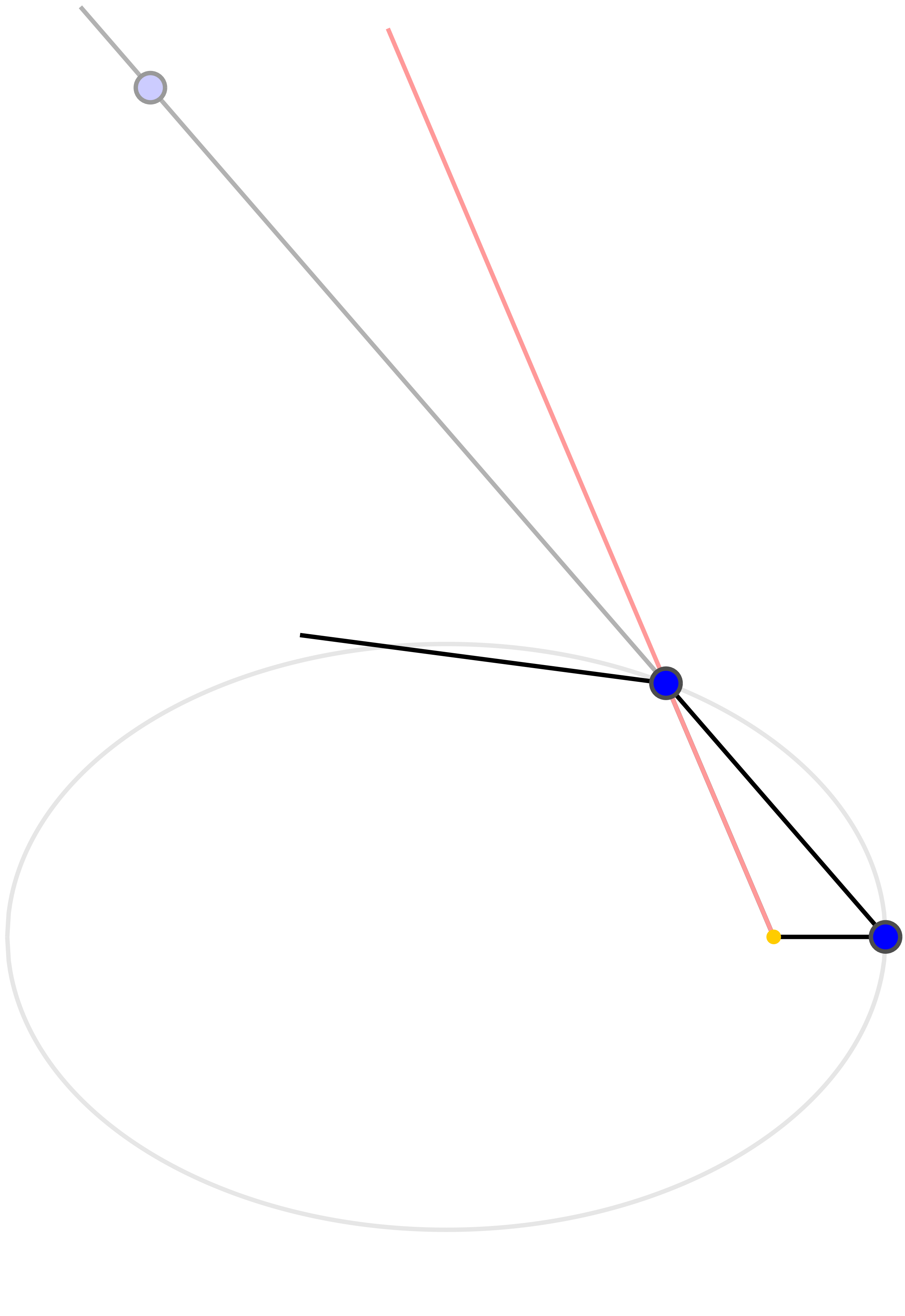


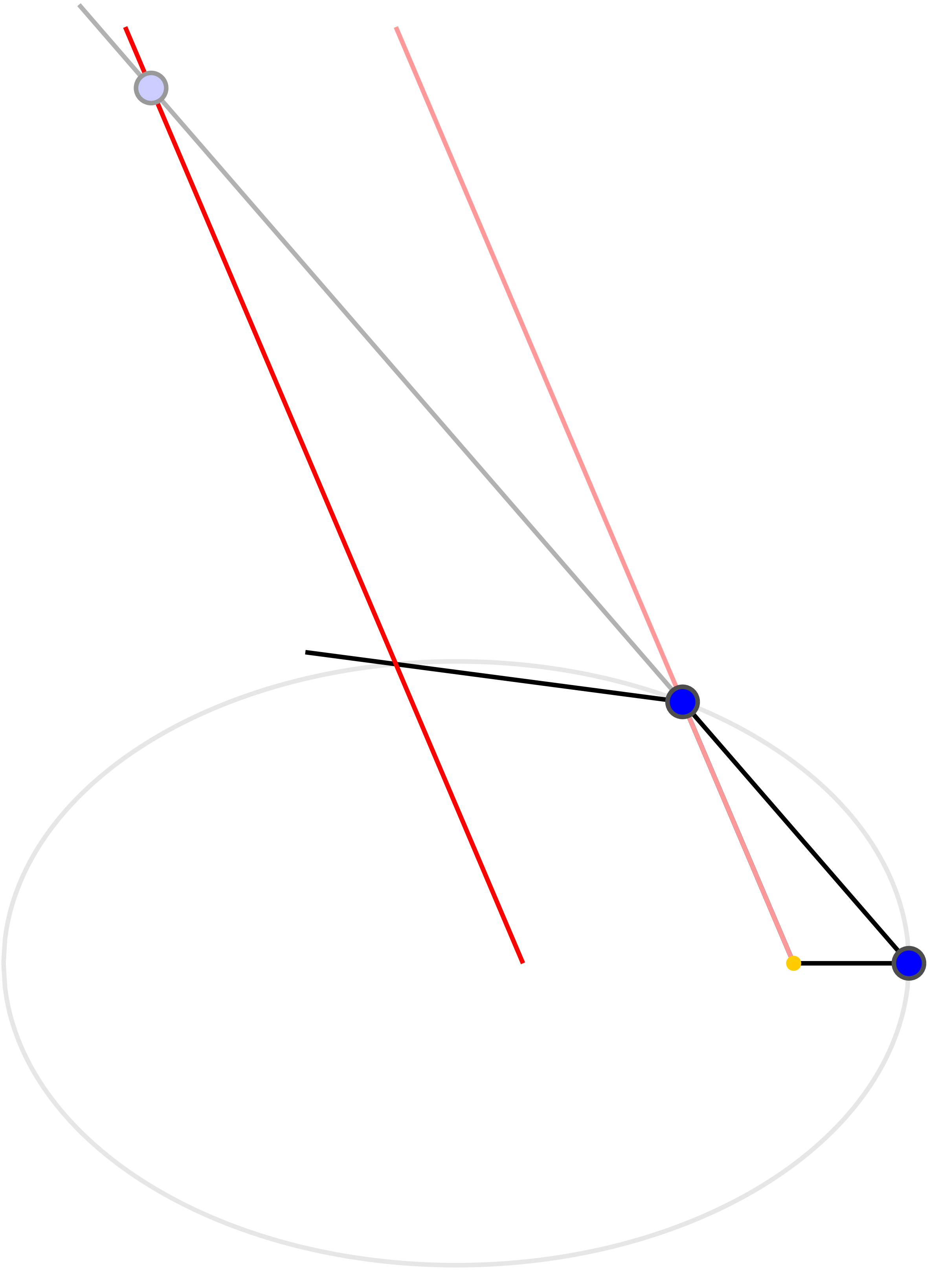


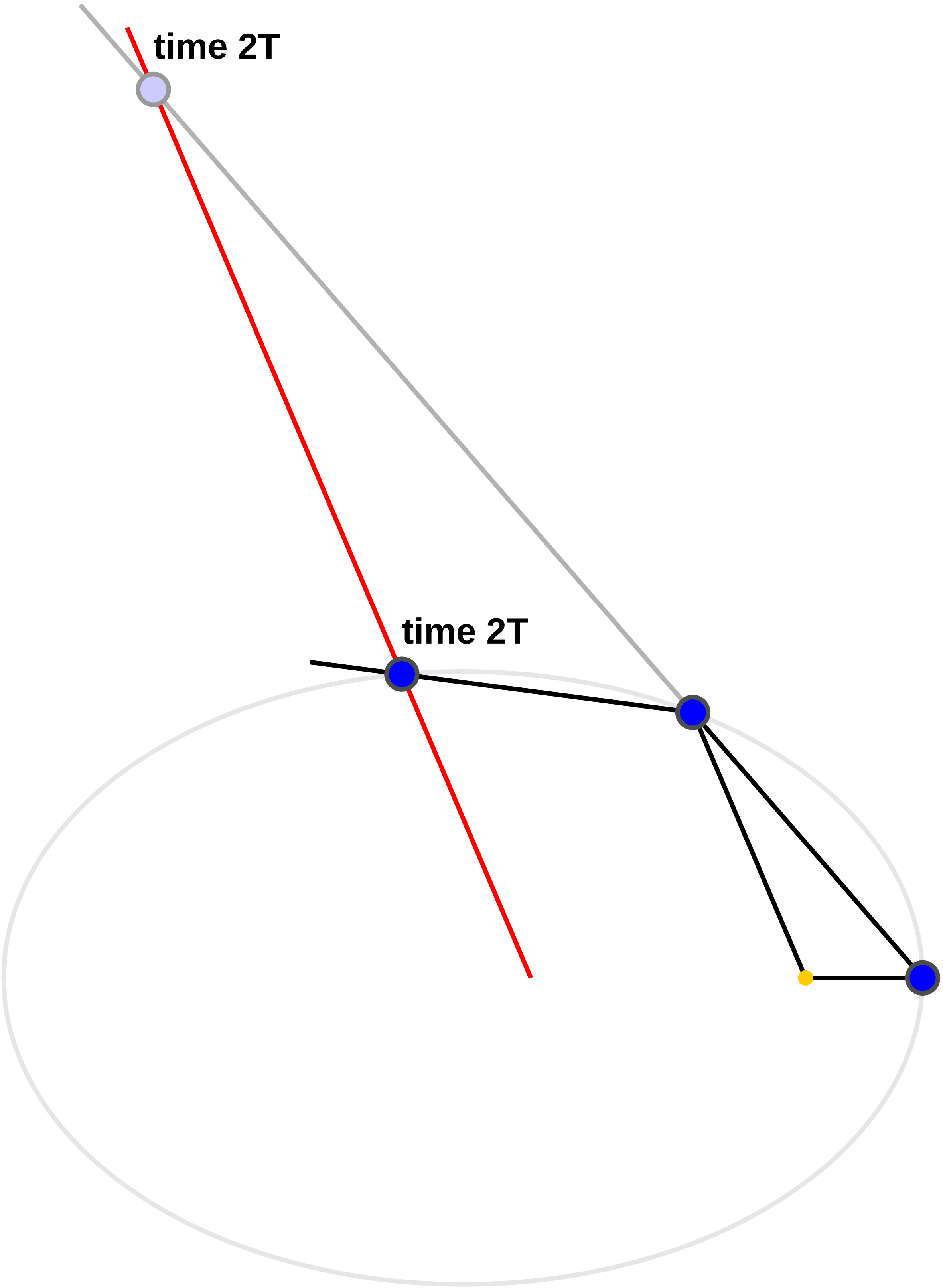


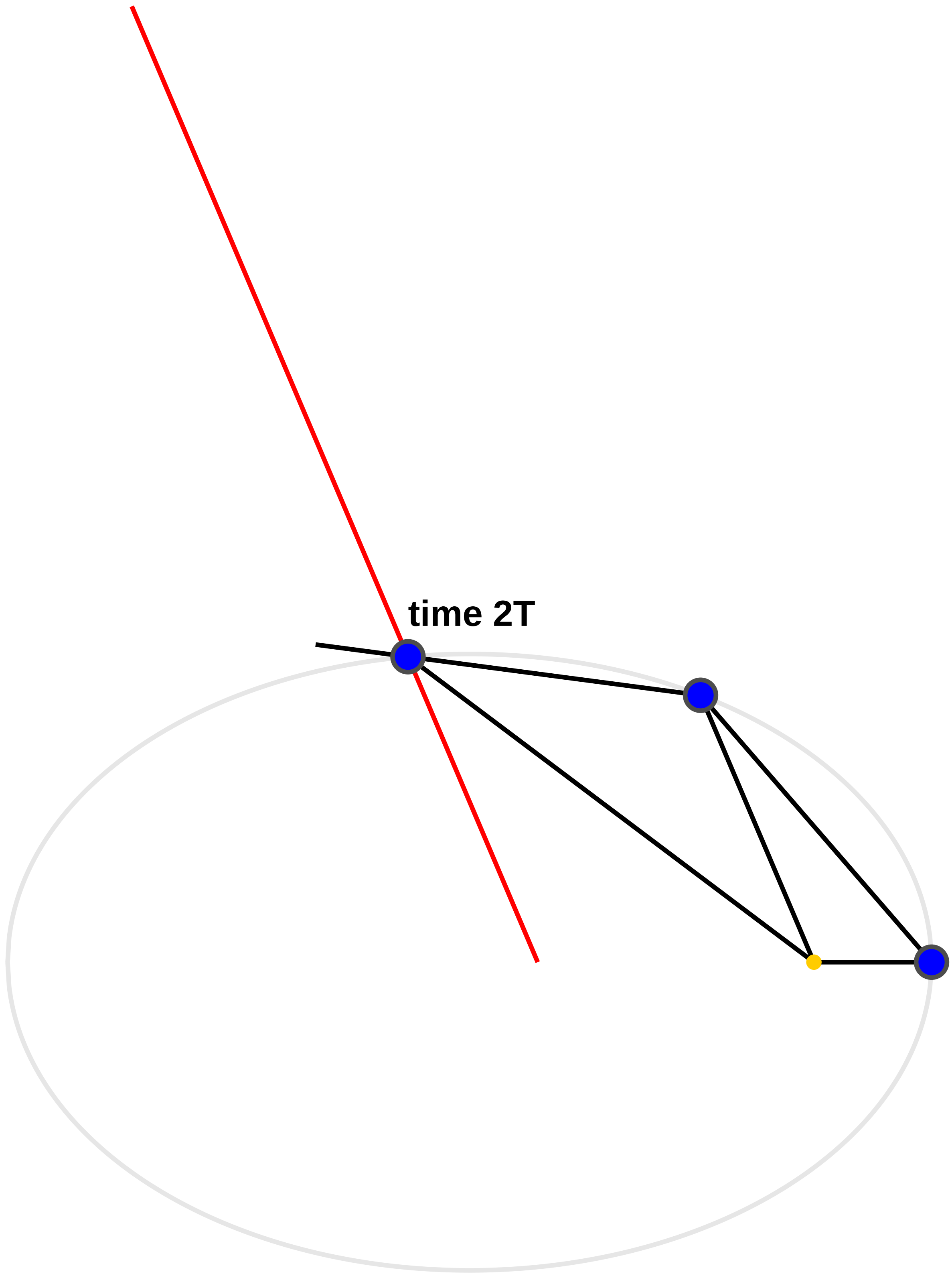

time 2T



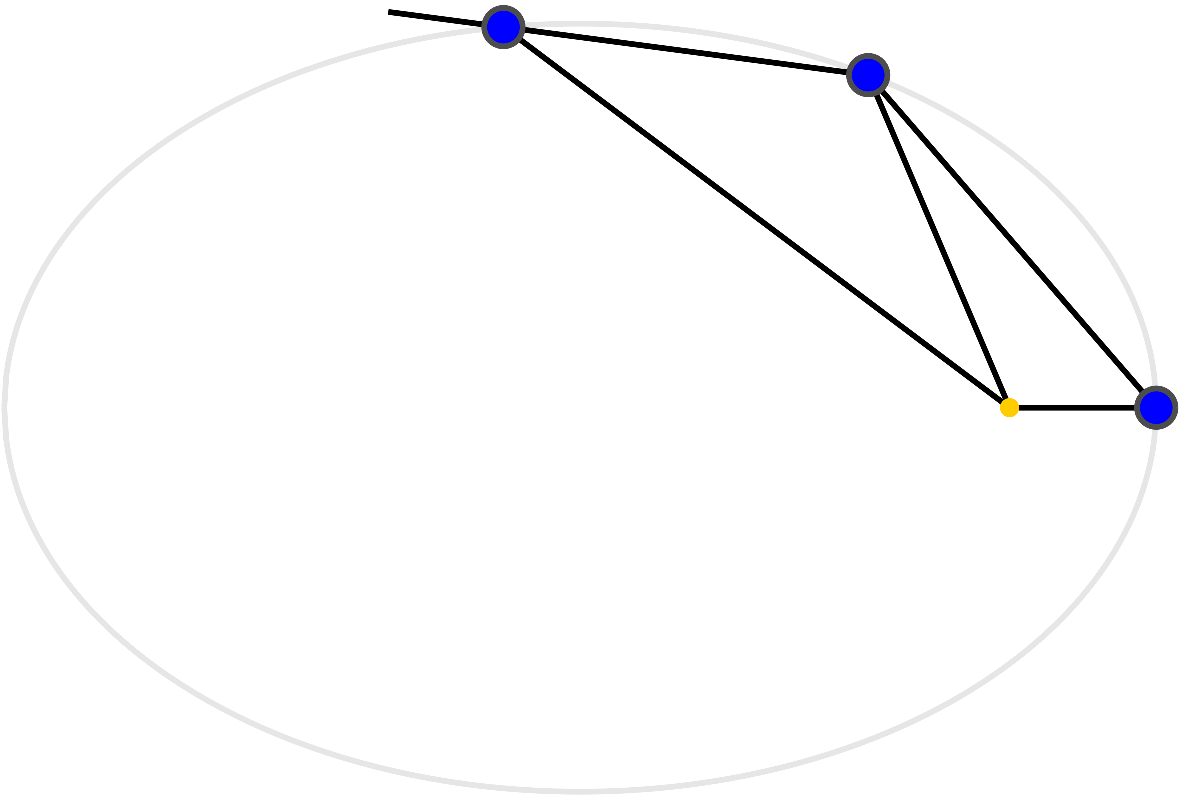




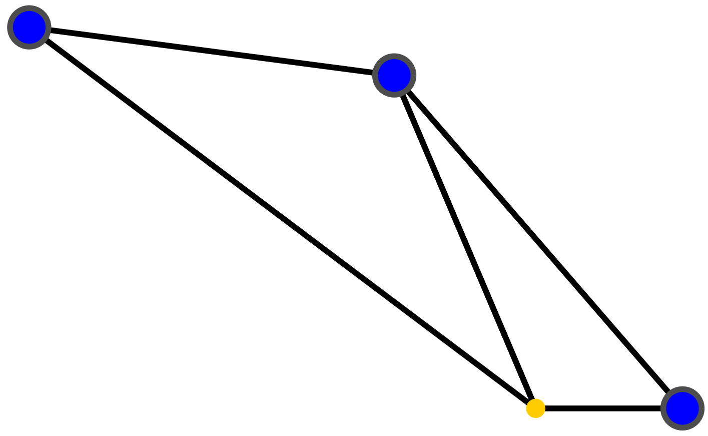

time 2T
time 2T


time 2T

At intervals of time T.



At intervals of time T.



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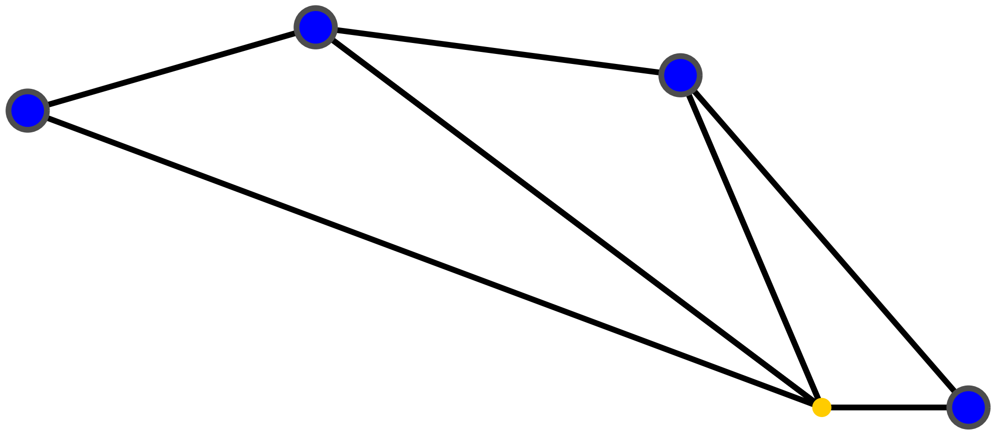

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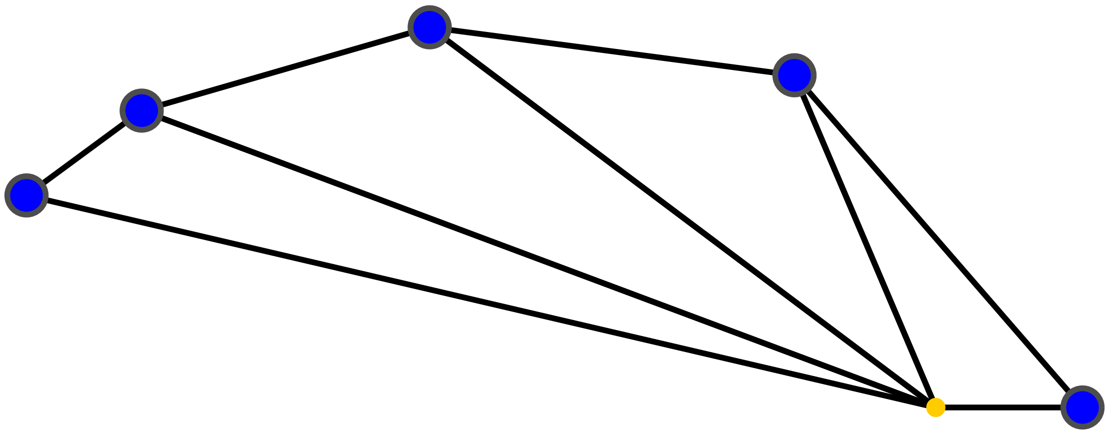
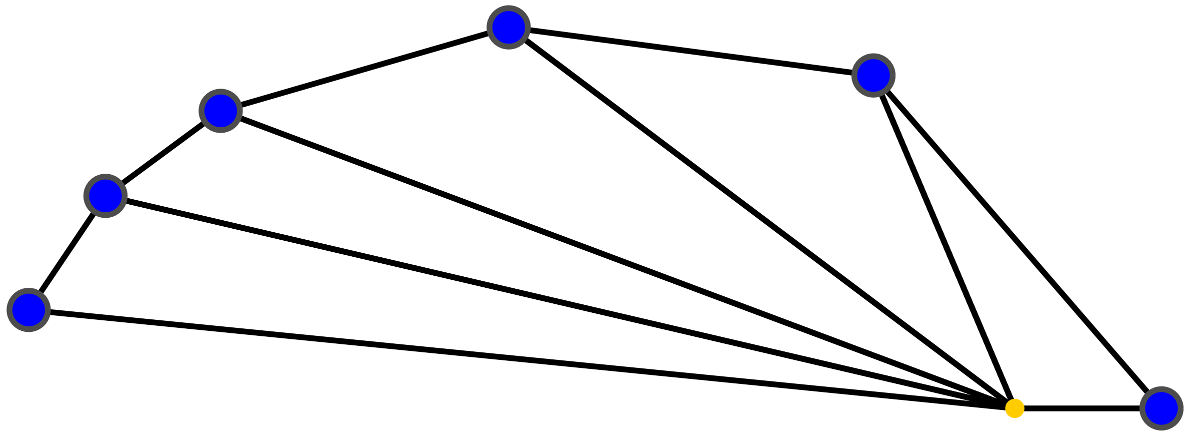
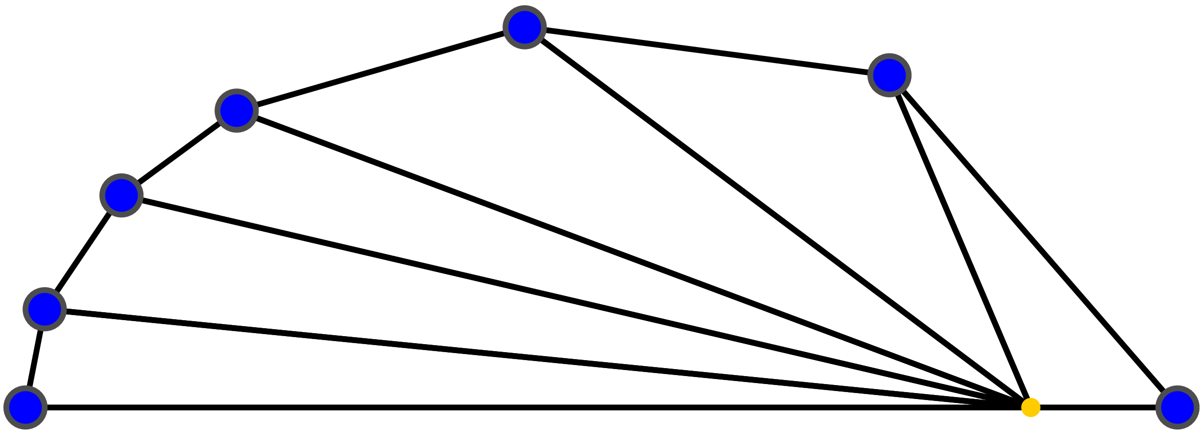


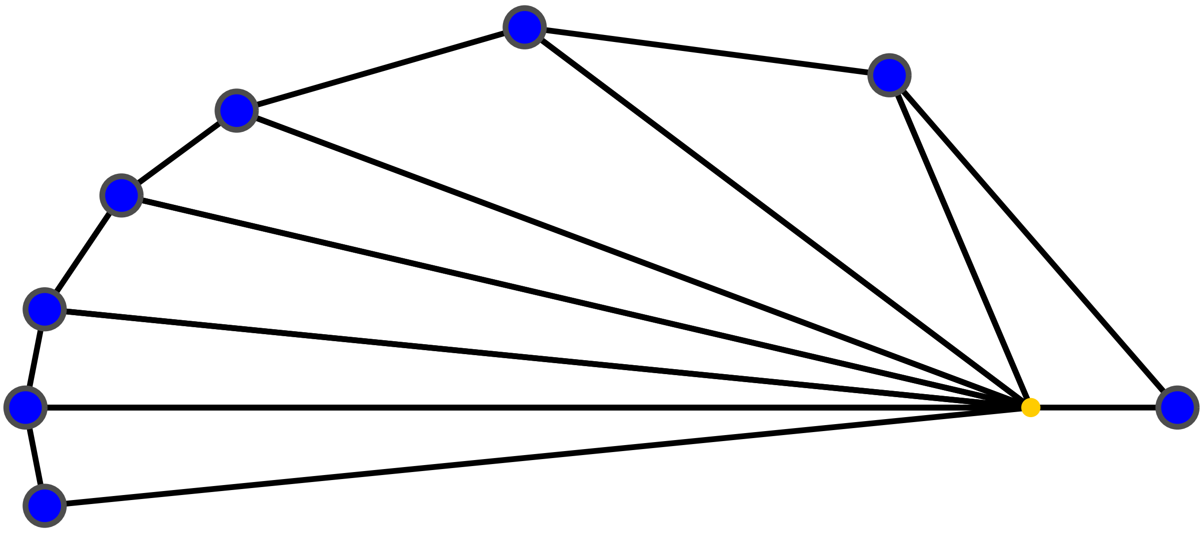
At intervals of time T.



At intervals of time T.



At intervals of time T.



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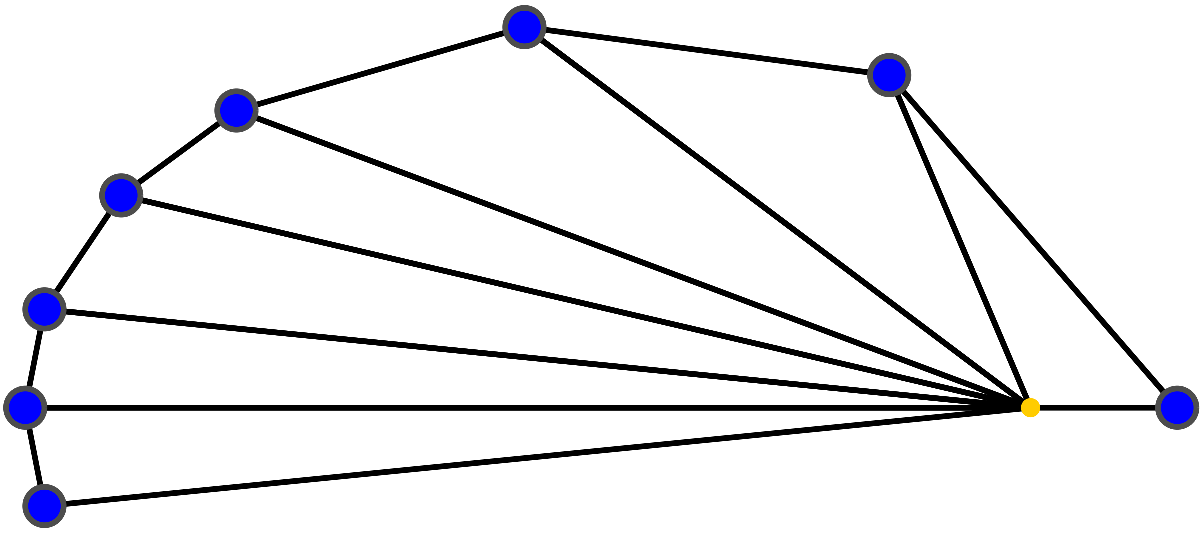
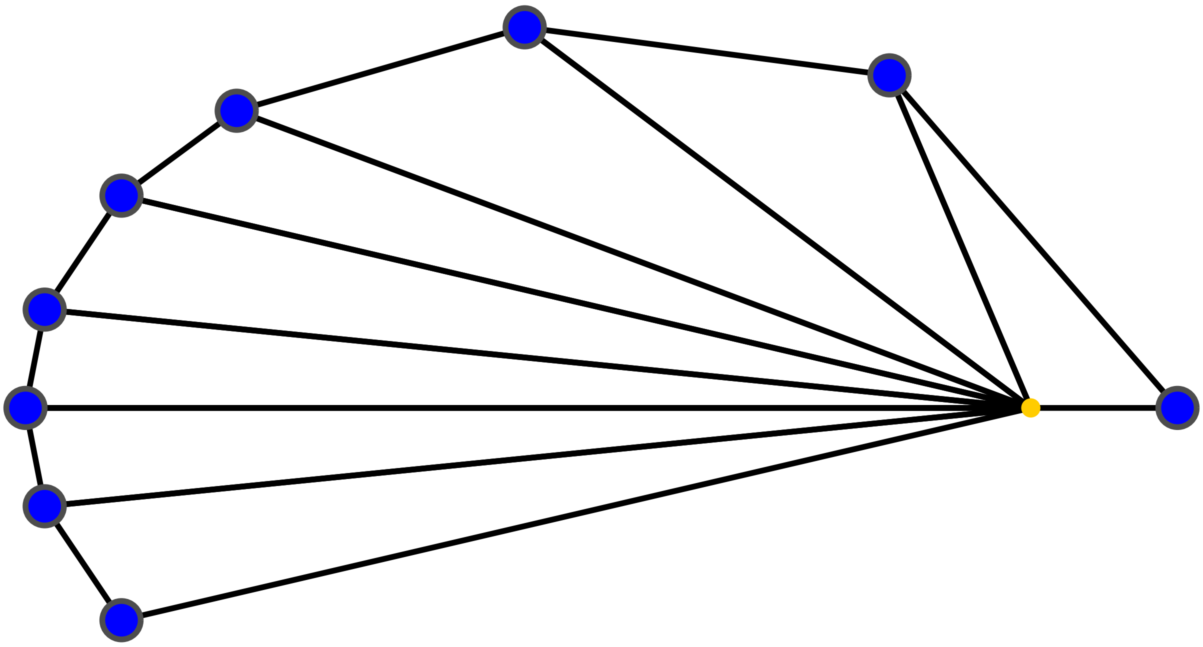
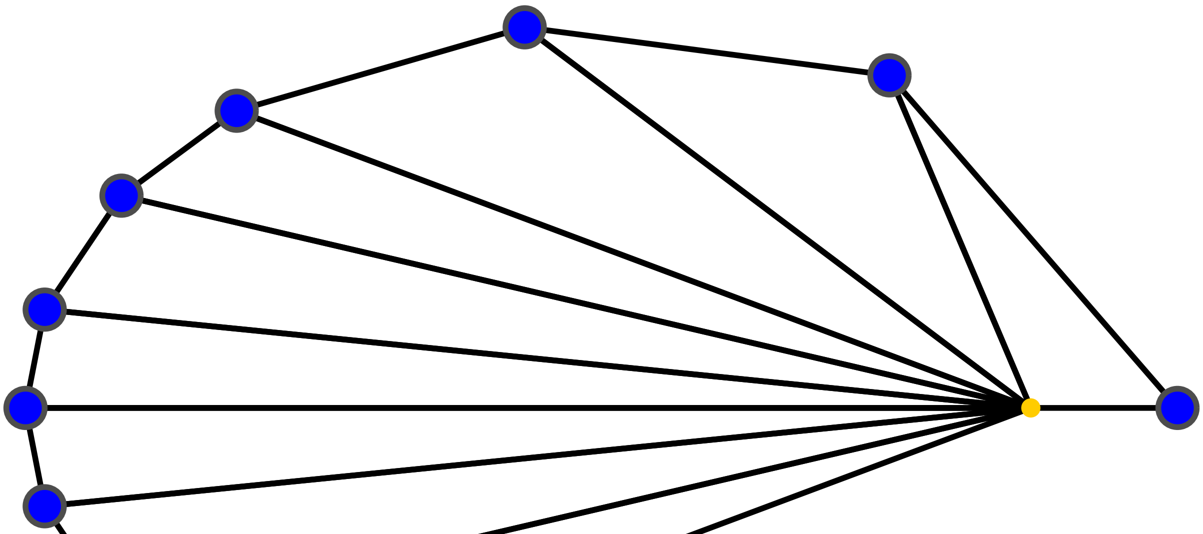


At intervals of time T.



At intervals of time T.



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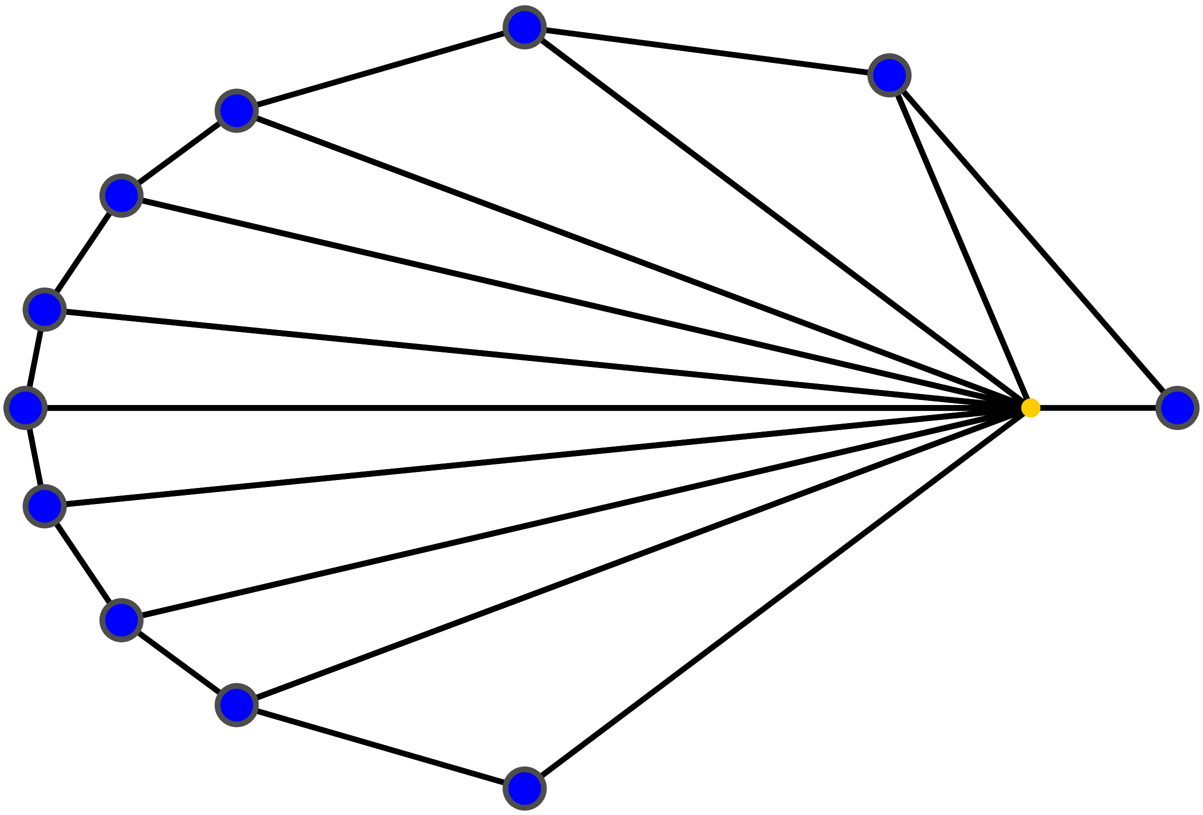
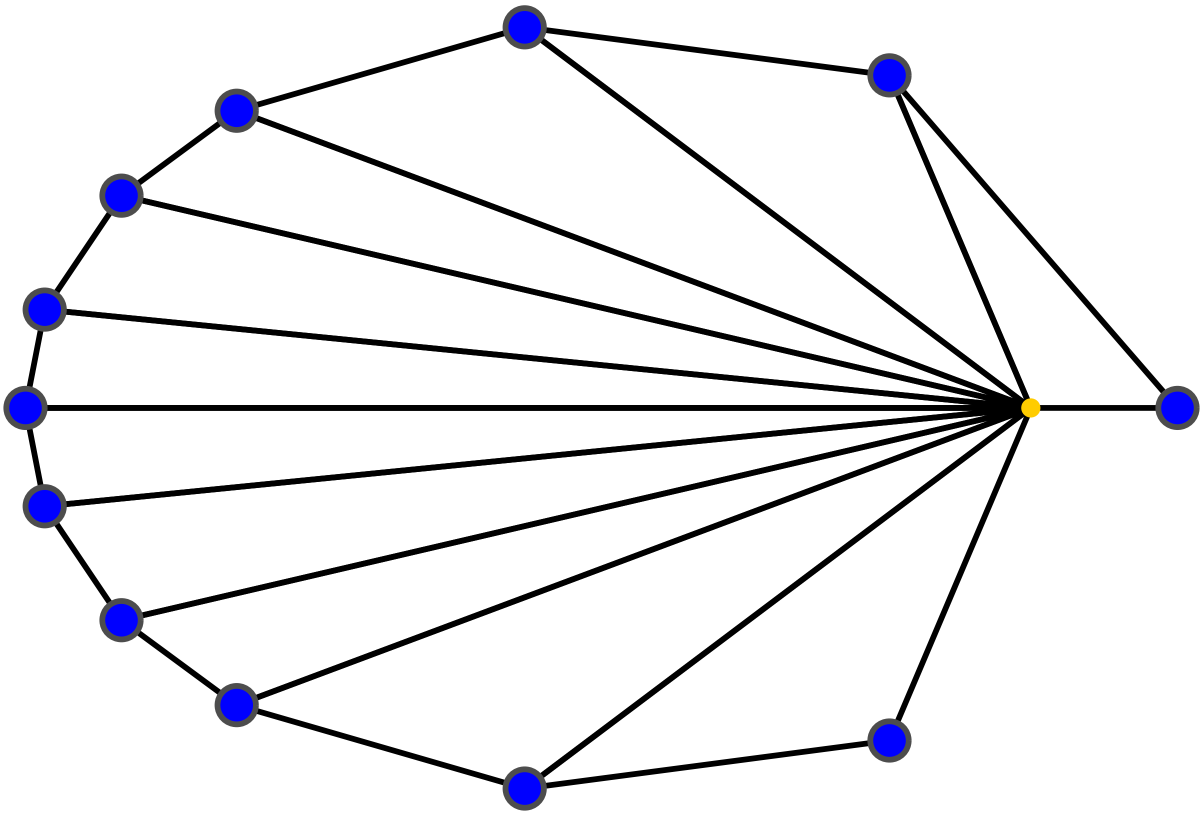
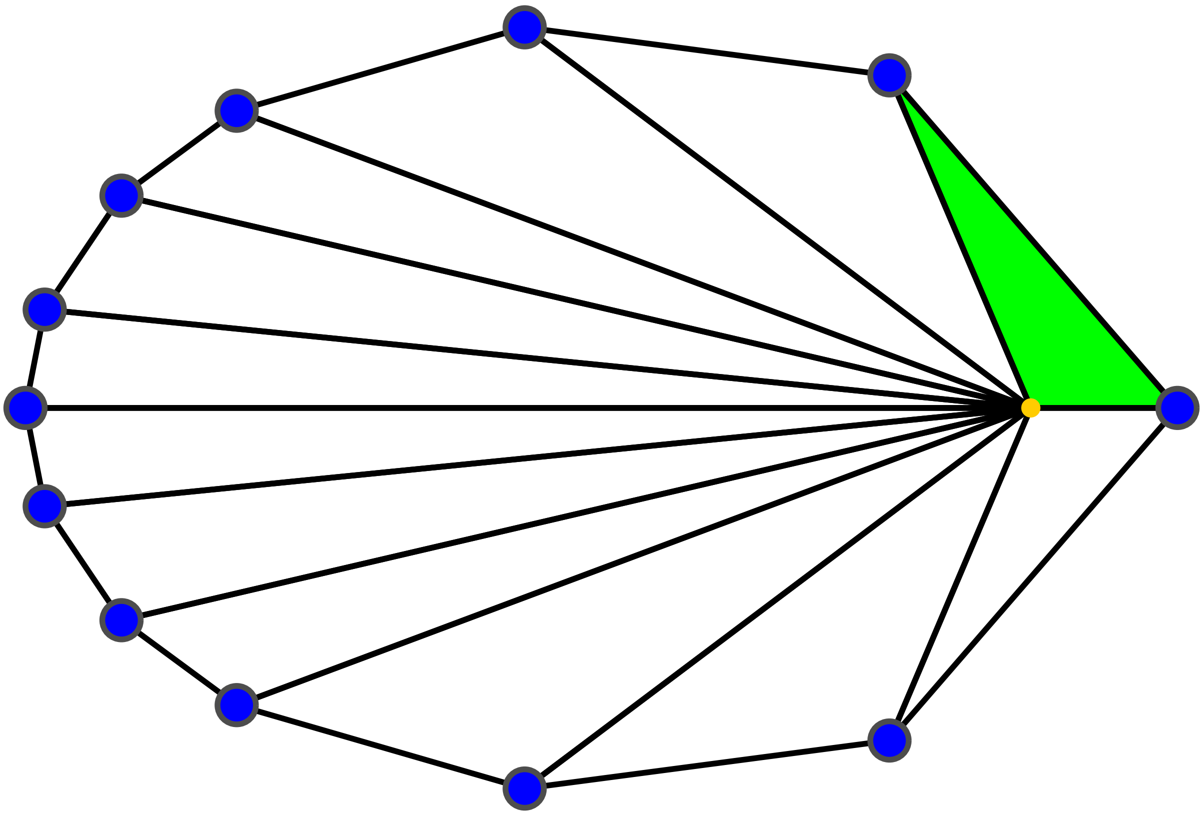


At intervals of time T.



At intervals of time T.



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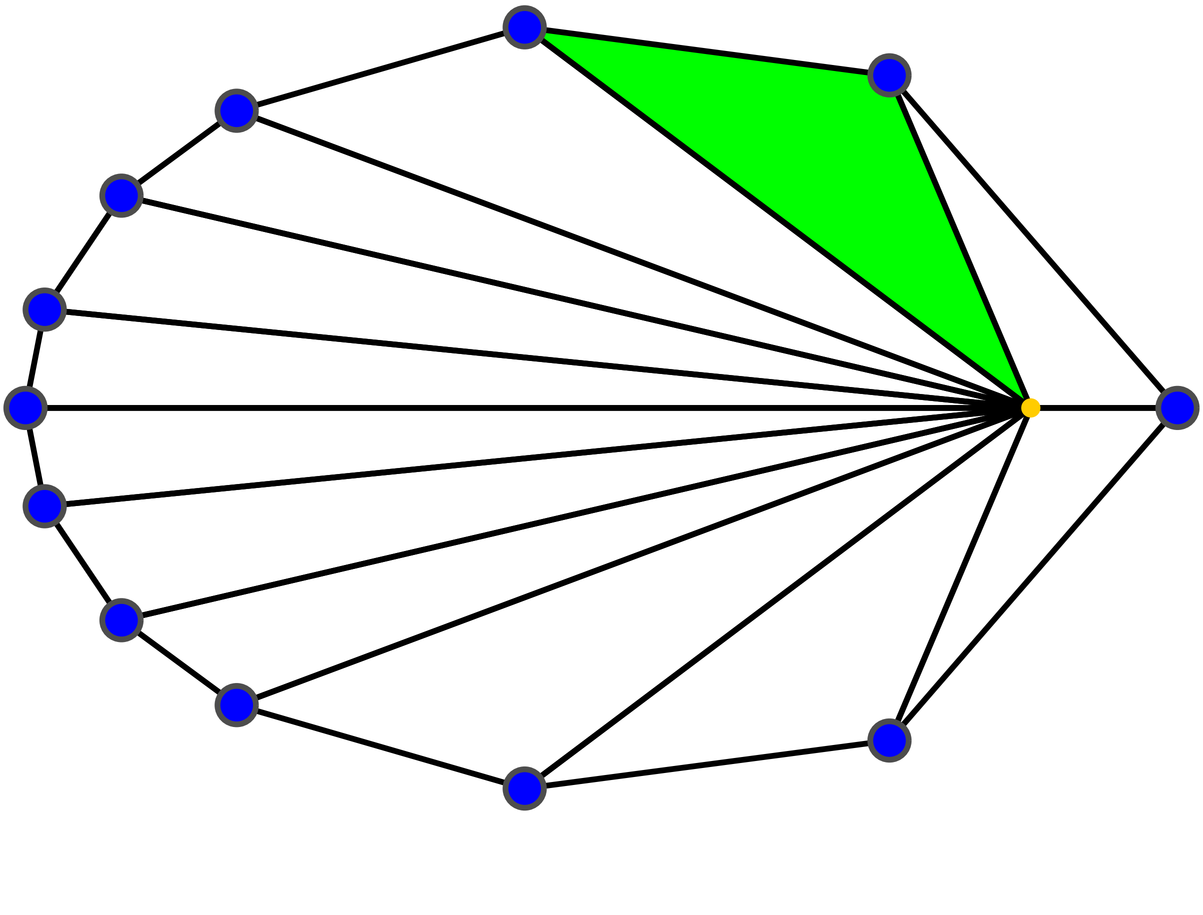

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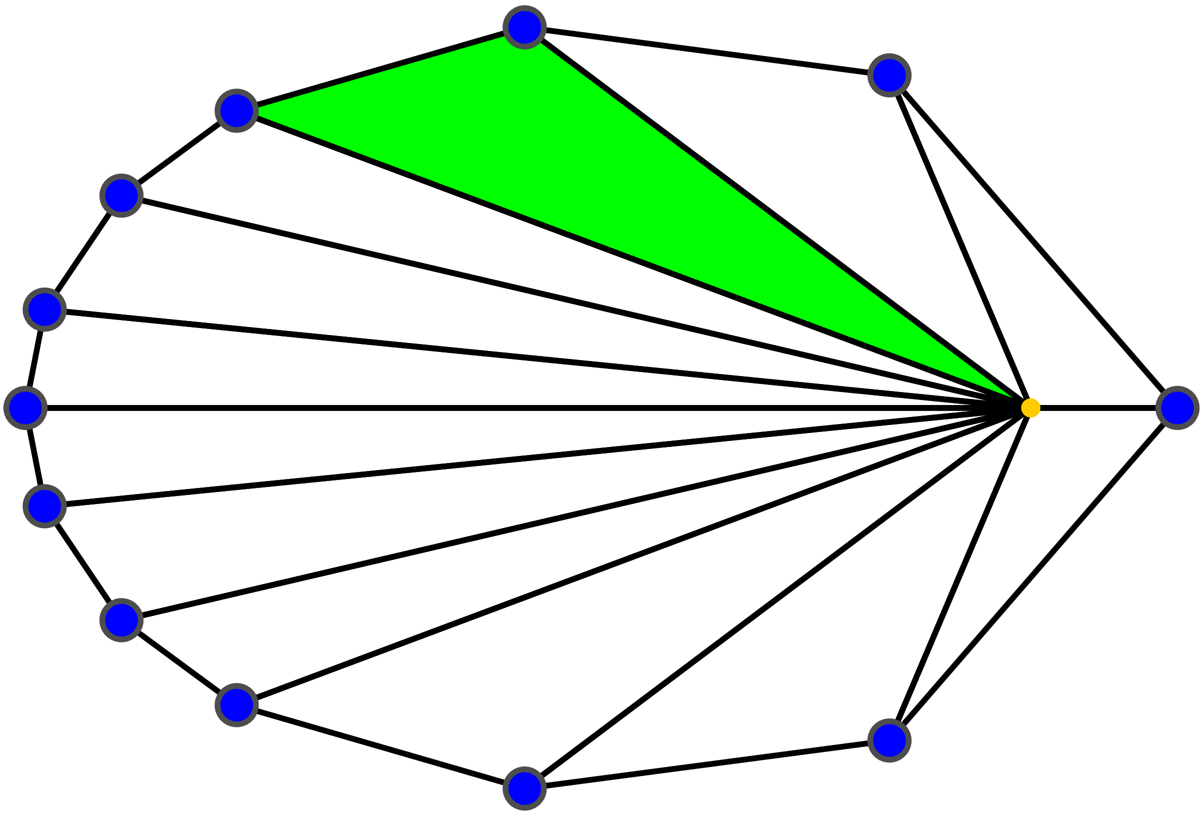

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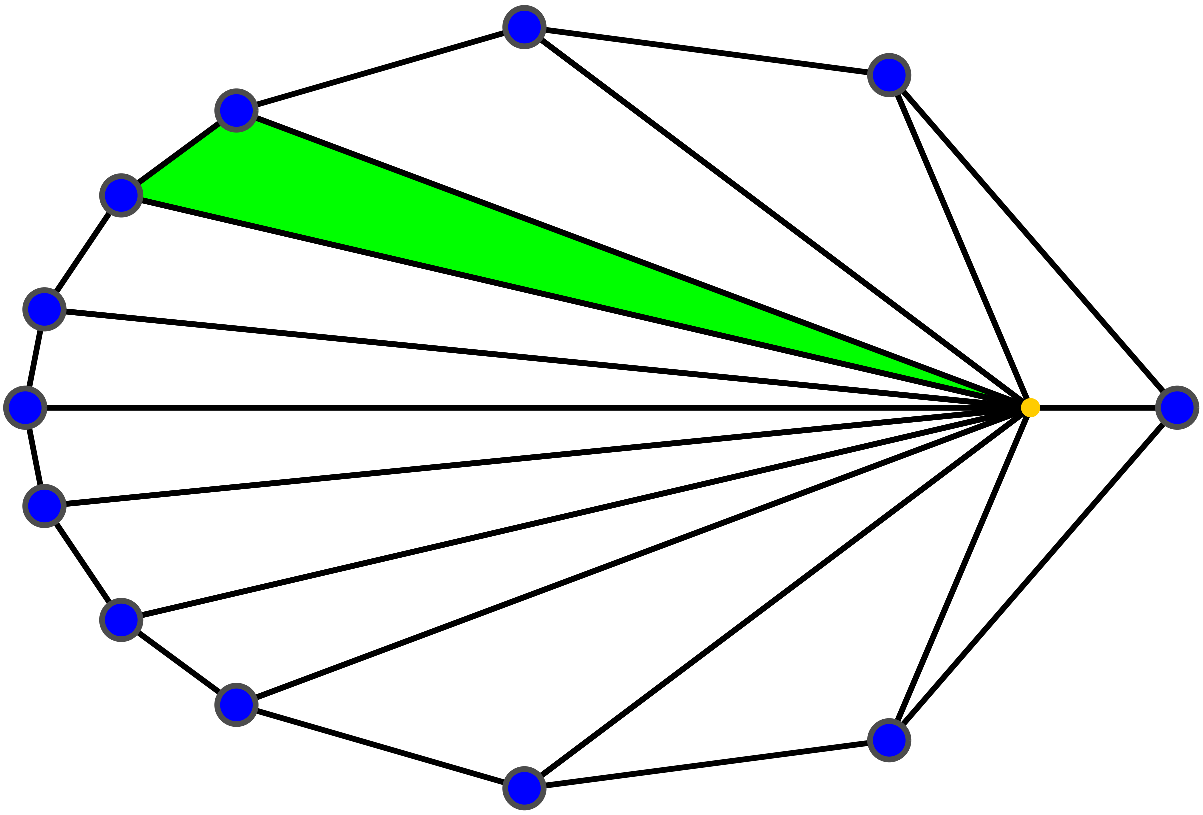

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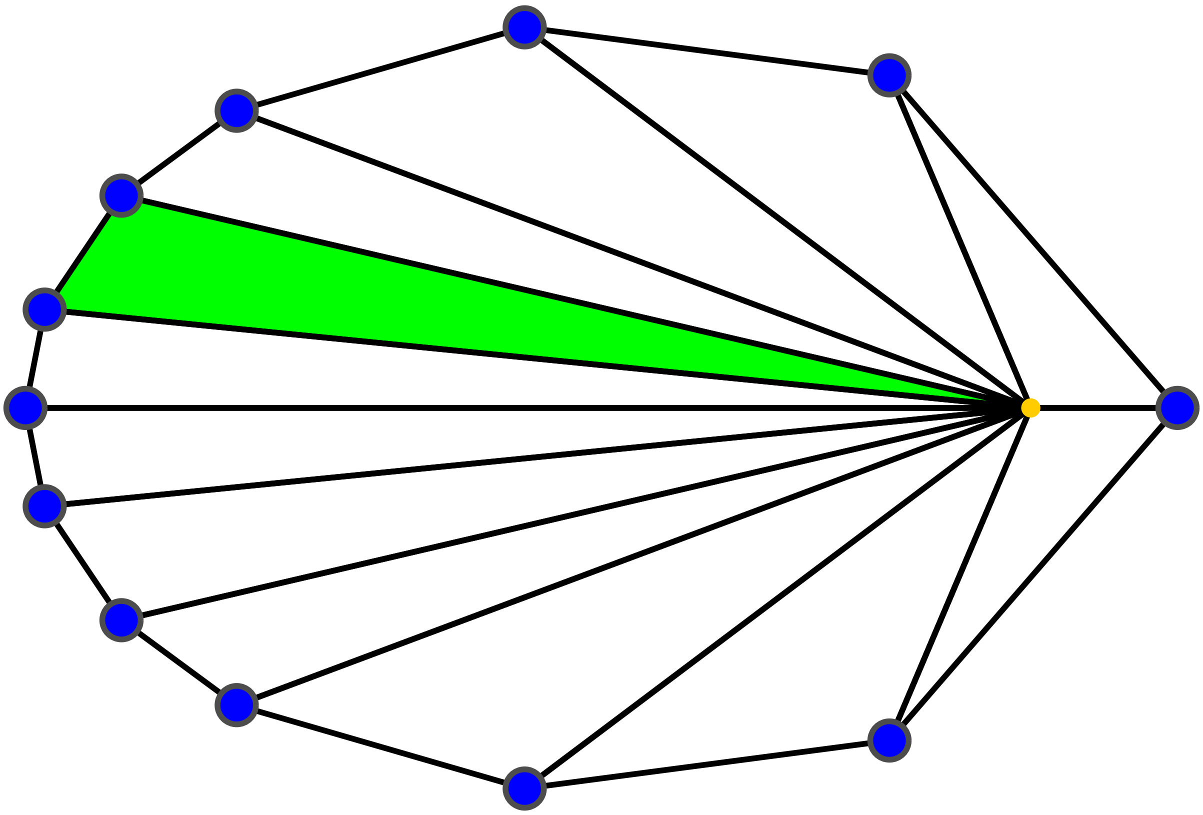

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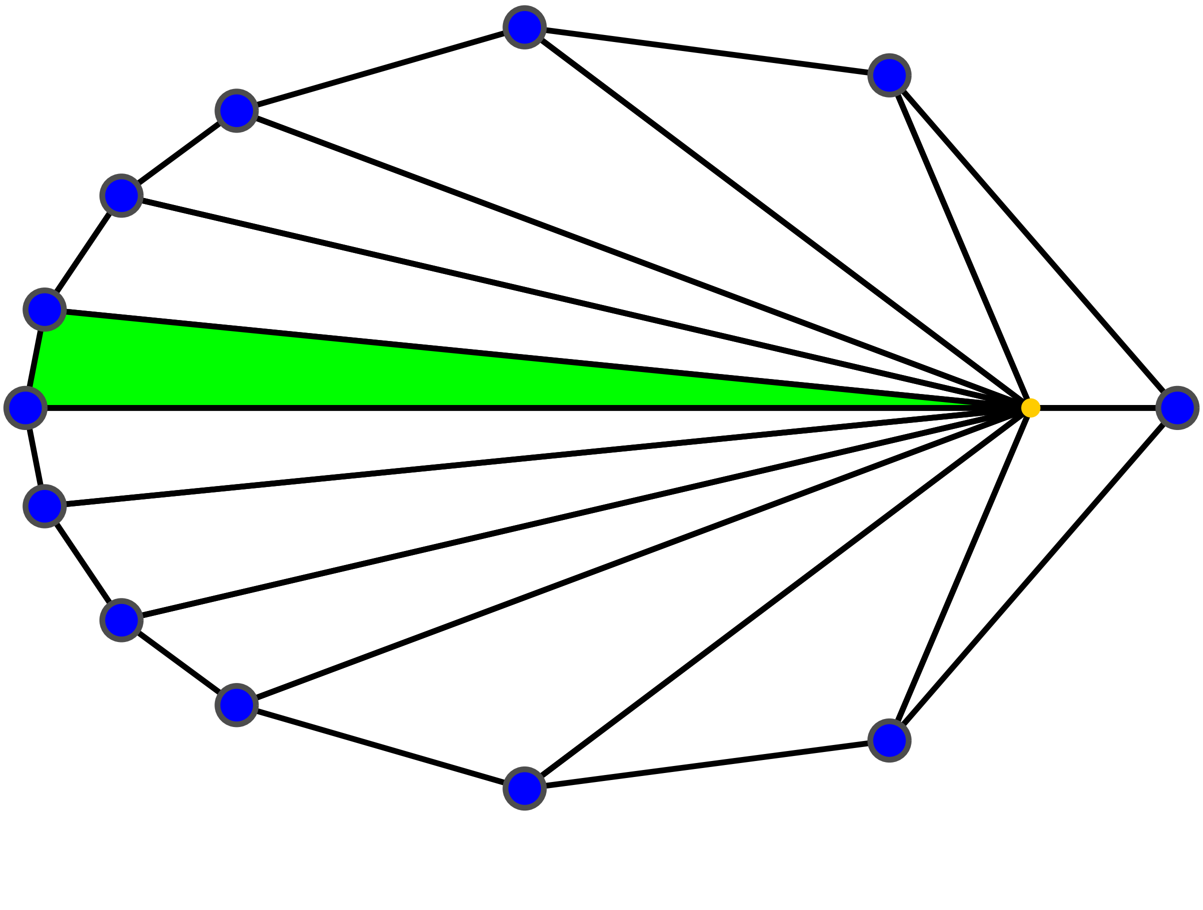

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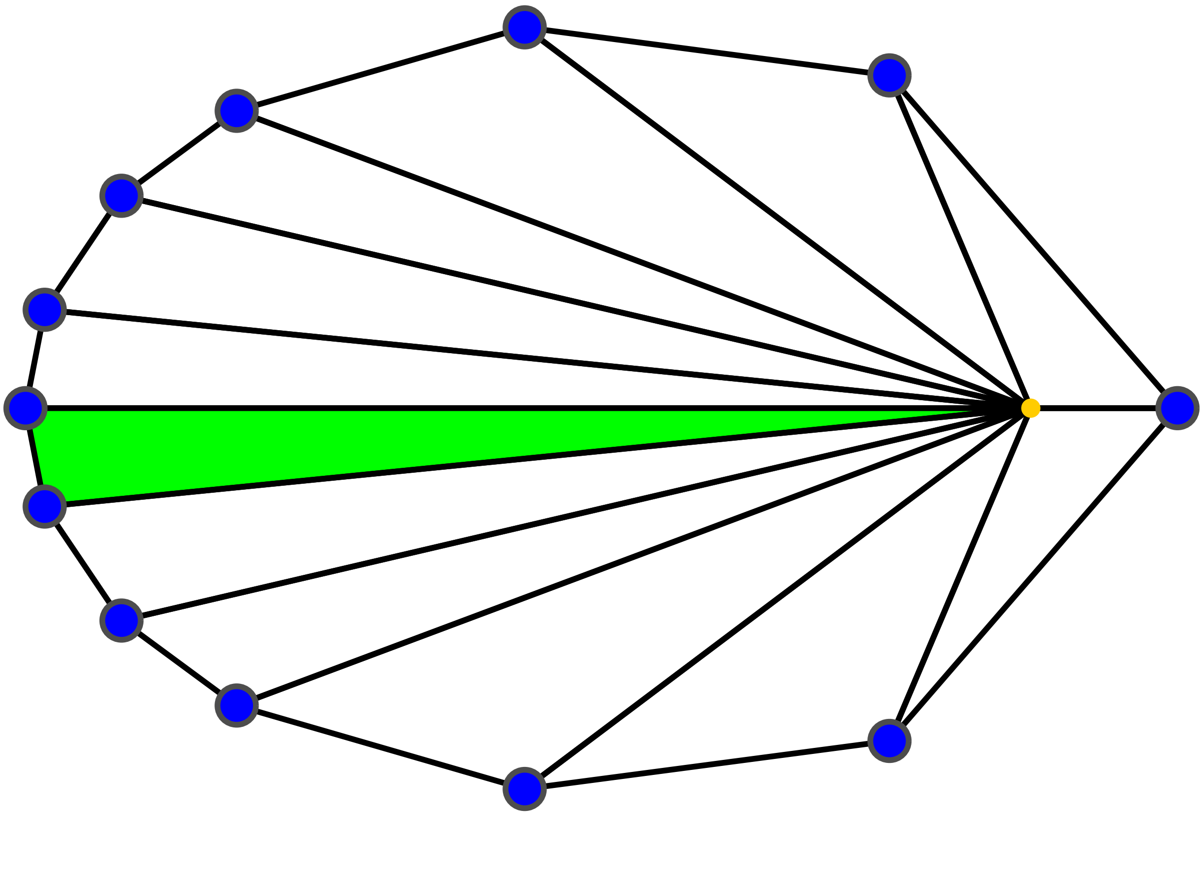

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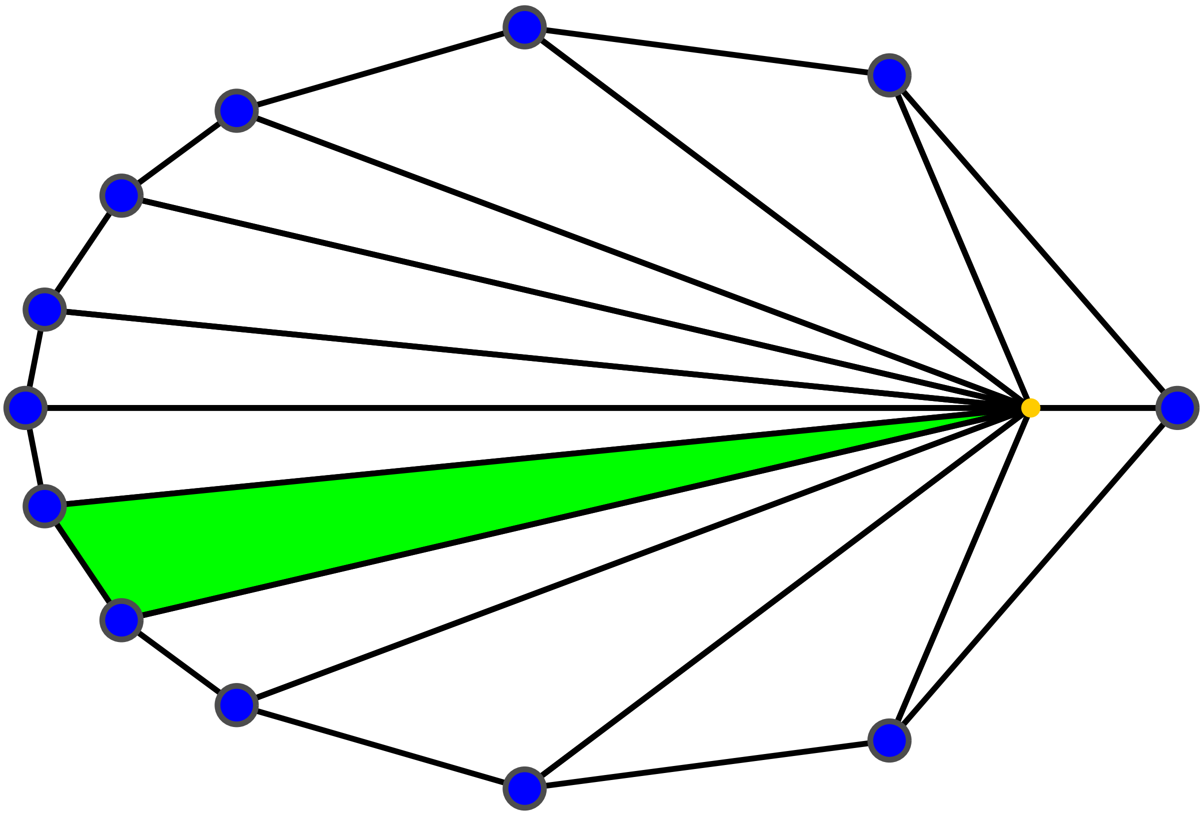

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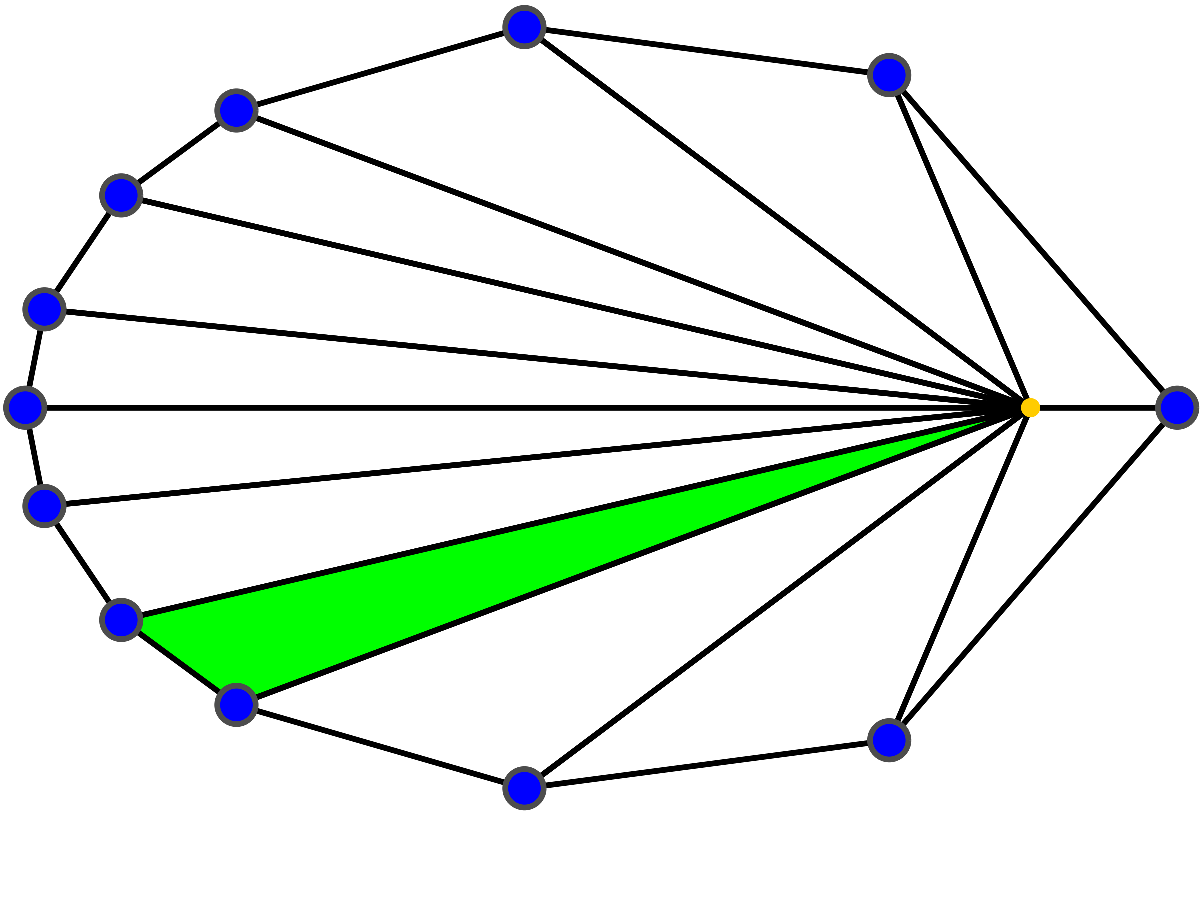

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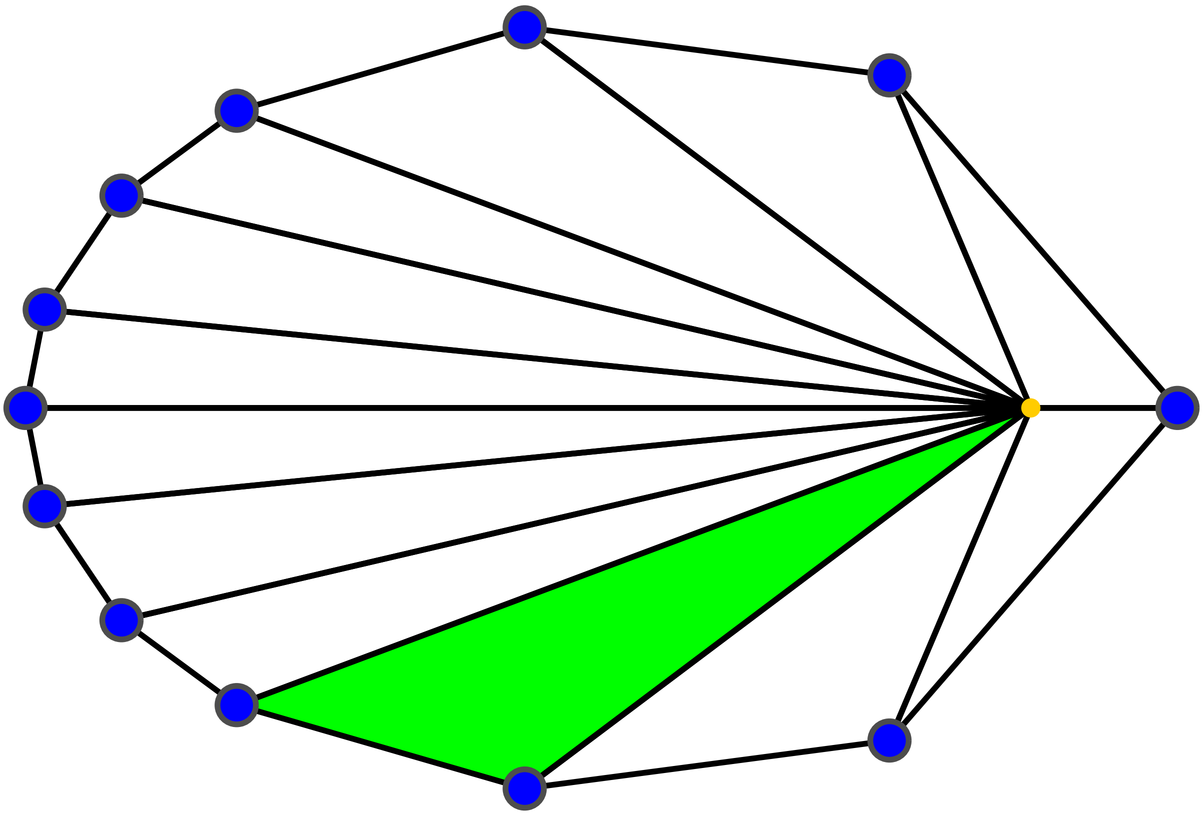

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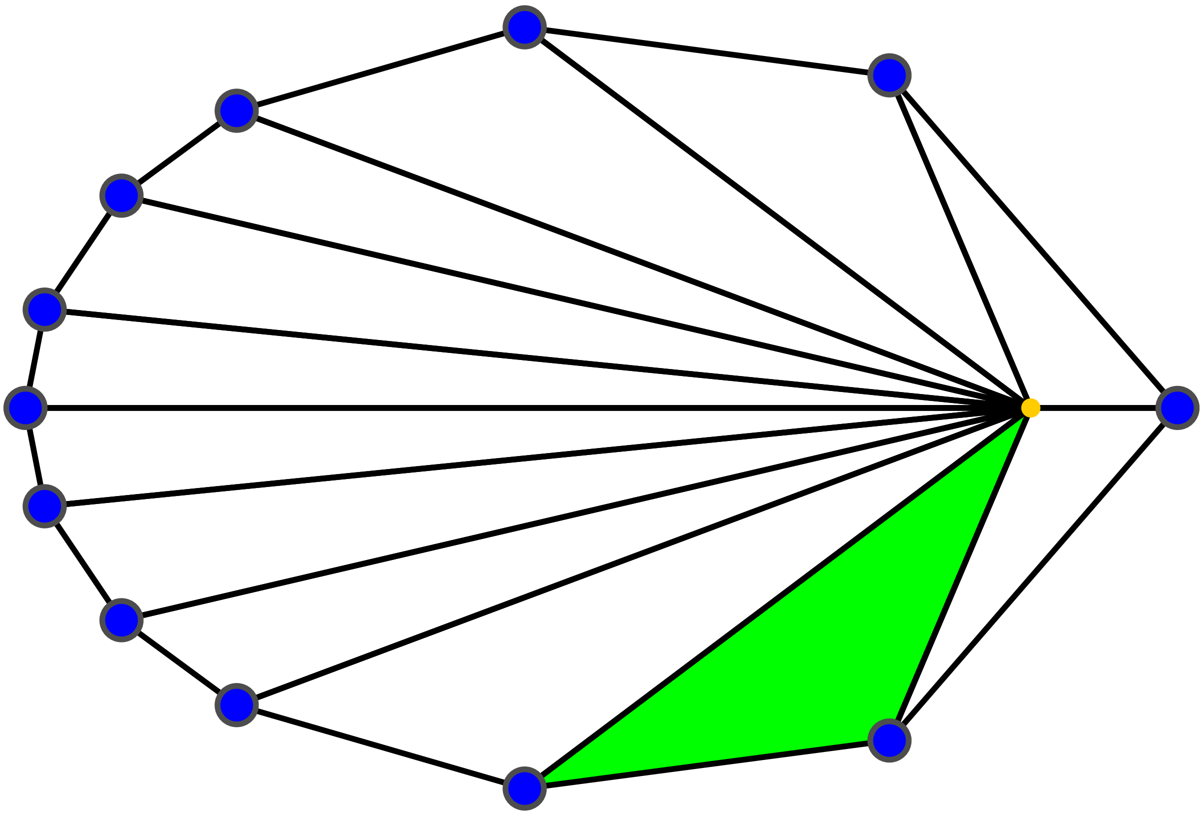

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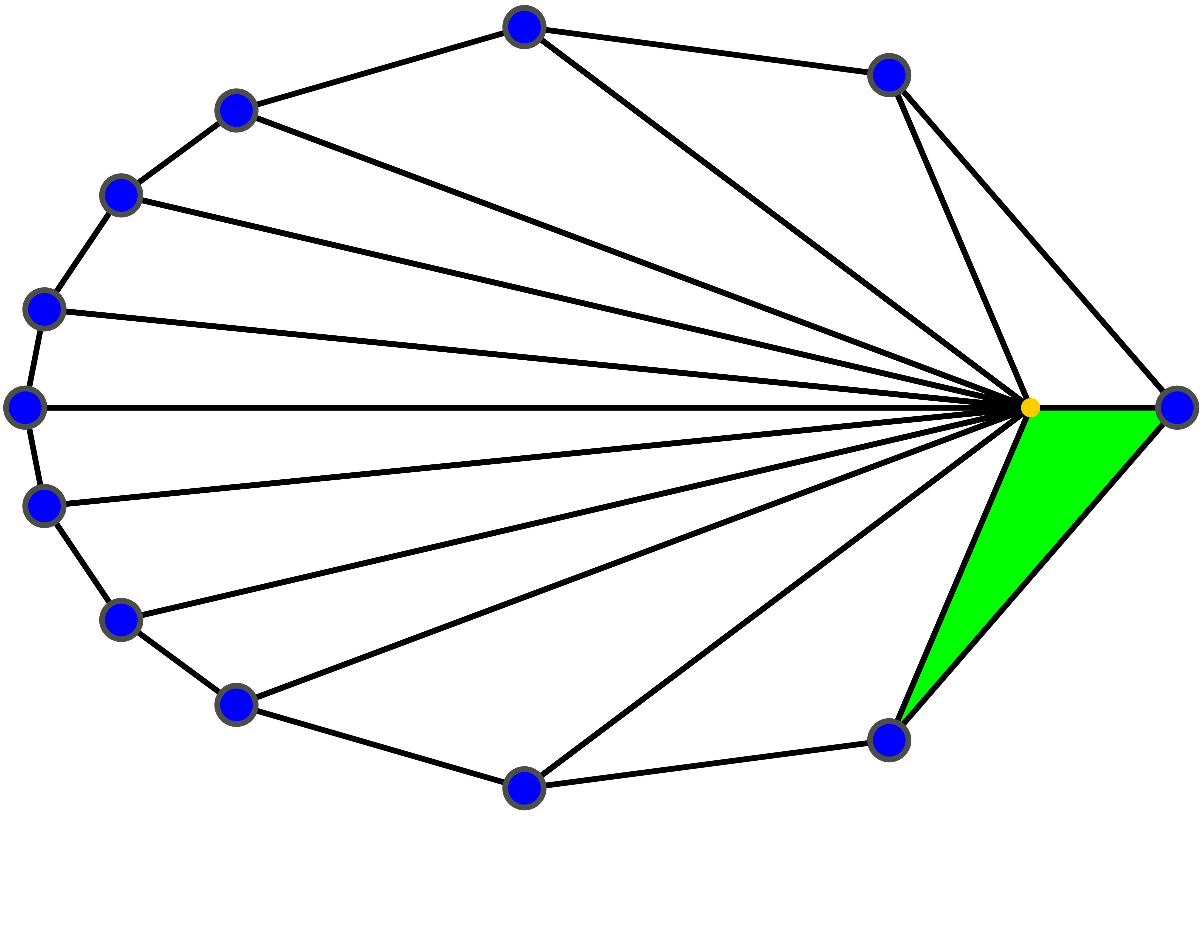
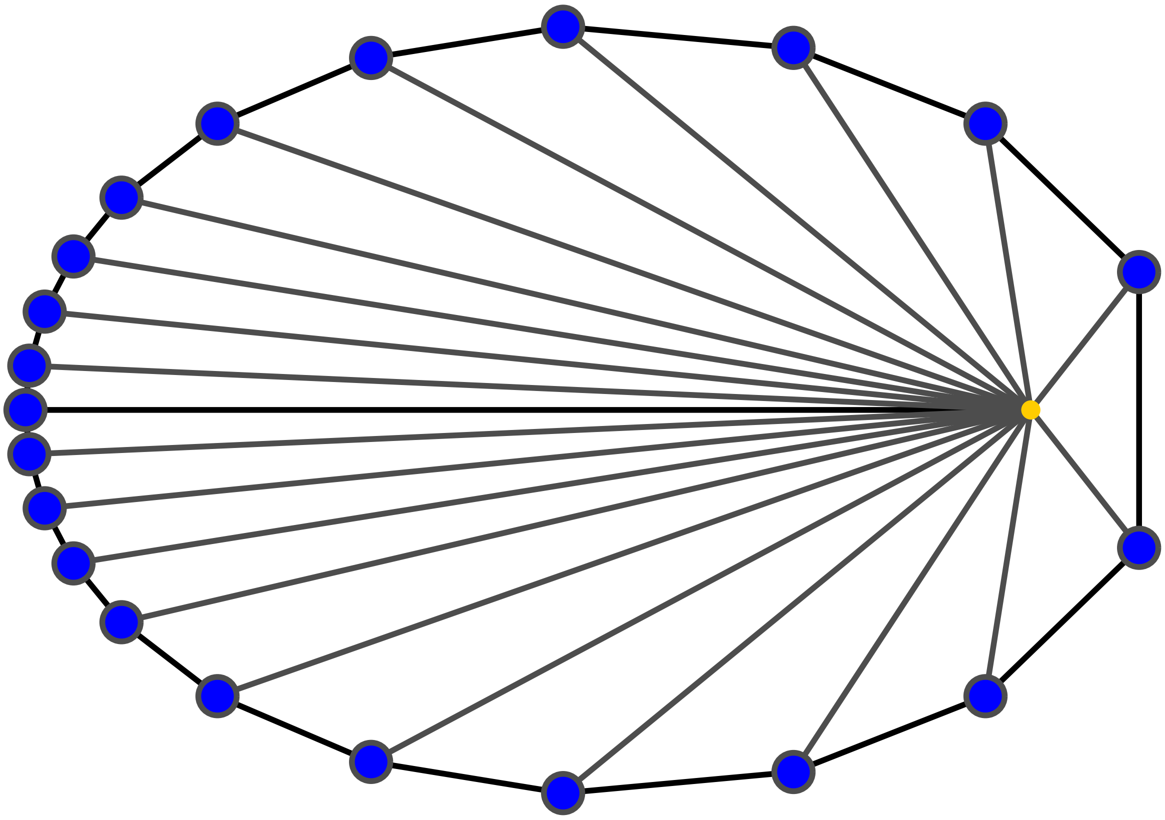


At intervals of another time T.



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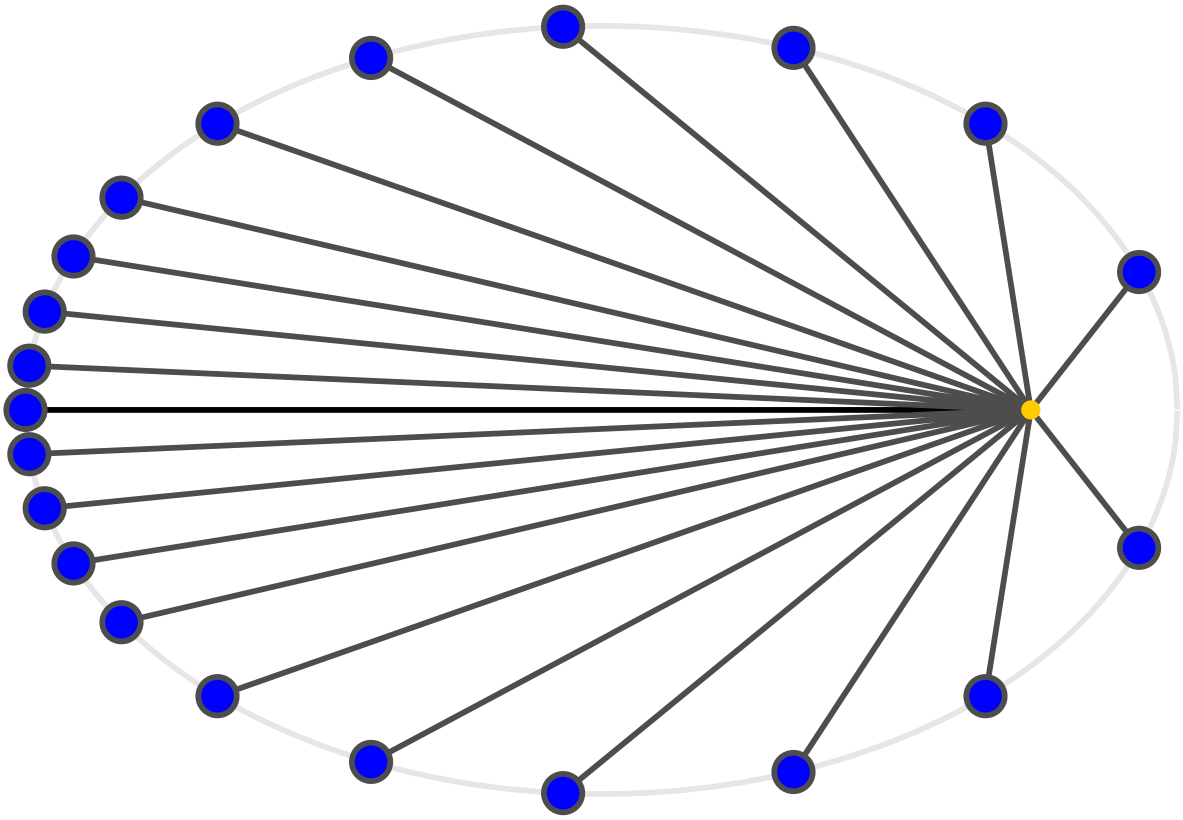
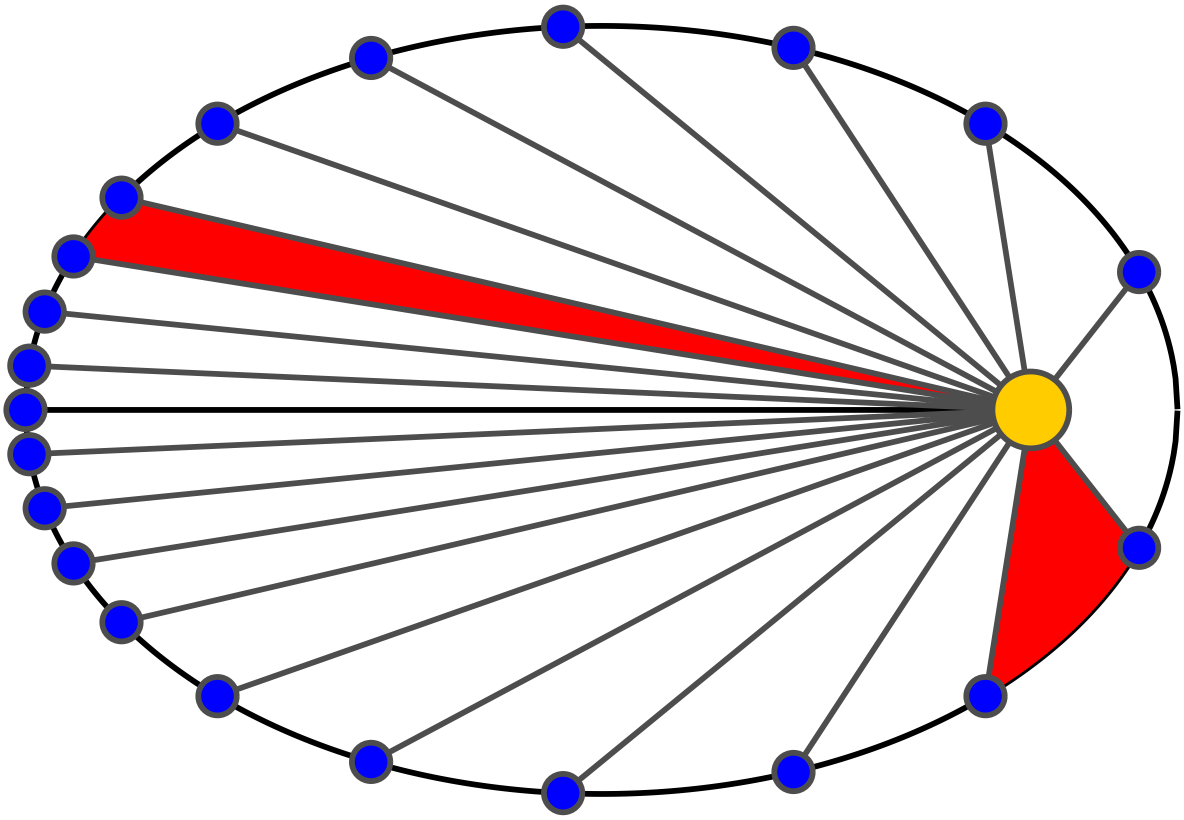


Kepler's second law states that as the planet moves, an imaginary line joining the planet and the Sun sweeps out equal areas in equal time intervals.

(Freedman, p75)

As the planet moves closer to the Sun it moves faster then when it is farther away.



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Merry

Christmas!

and

Happy

New Year!!